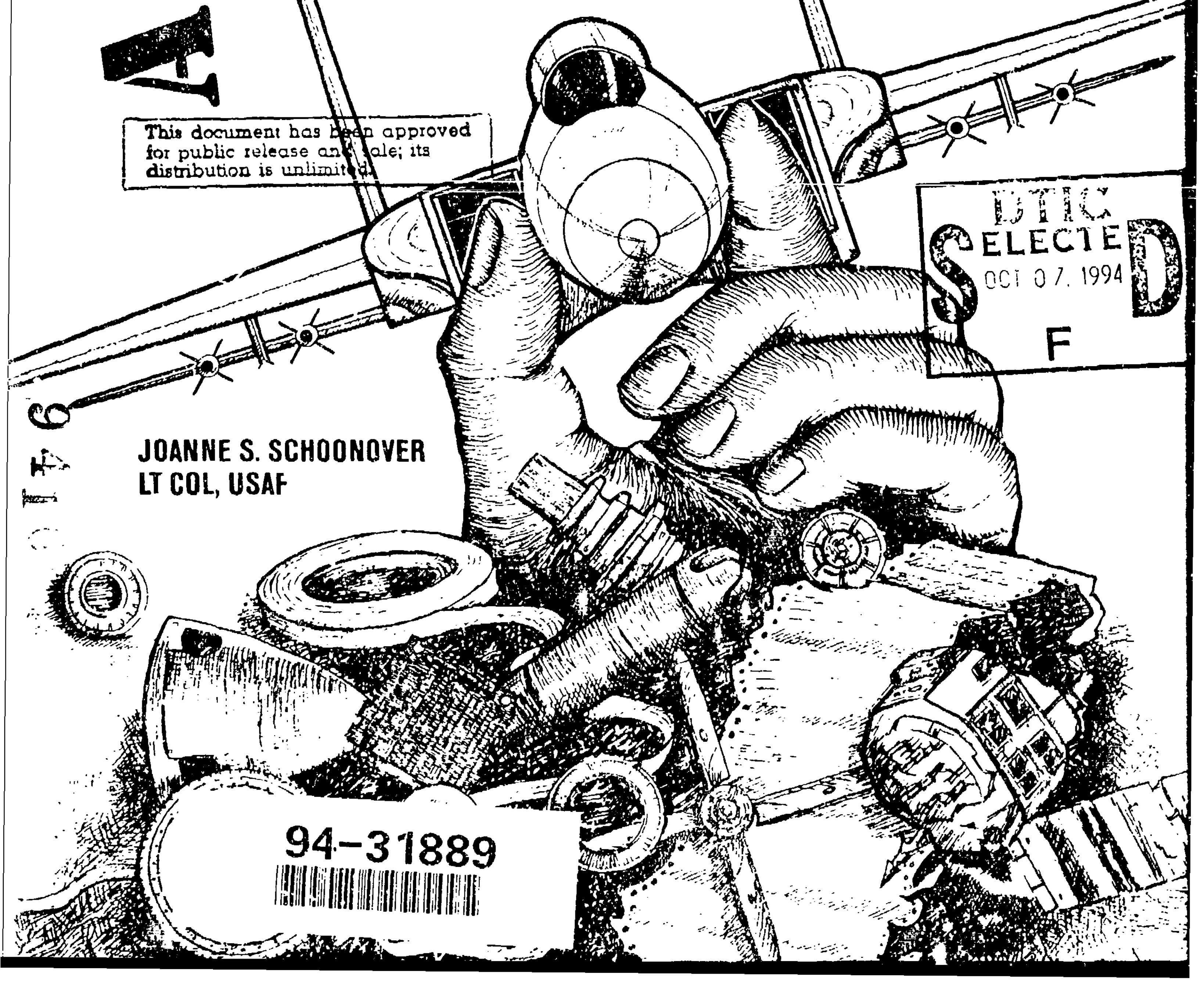
ACCELERATED AIR FORCE ACQUISITION PROCESSES

AIR FORCE SYSTEMS COMMAND



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Accelerated Air Force Acquisition Processes

Lessons Learned from Desert Storm

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Foreword

It is the role of Air Force Systems Command to provide new weapon systems and combat capability to commanders and airmen in the field. We normally think of the acquisition processes that deliver those systems and capabilities as requiring several years. During Desert Shield and Desert Storm, however, we demonstrated that our processes, procedures, and people are flexible and that they can quickly deliver new systems and capabilities into the hands of our warriors when the need arises.

This study analyzes the processes and procedures the command used to accelerate the delivery of weapon systems and combat capabilities during the Gulf crisis. It confirms that some of our normal acquisition procedures continued to work well during accelerated activities. It uncovered problems in other procedures. The study identifies still other areas where opportunities exist for improvements in our ability to respond quickly to contingencies in the future. We must learn from and apply these lessons if we in the acquisition community are to continue to provide our fighting forces with the most effective combat capability in the world.

Robert M. Johnston

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About the Author

Lt Col Joanne Schoonover

Lt Col Joanne Schoonover is an acquisition officer with more than 10 years of experience in that field. She joined the Air Force in 1978 and received her commission through Officer Training School. Her first assignment was as an aircraft maintenance officer at Norton Air Force Base (AFB), California, where she was responsible for the maintenance of C-141A and T-39 aircraft. Following that tour, she entered the acquisition career field at Vandenberg AFB, California, as a member of the Space Shuttle Activation Task Force. Here she managed the procurement of support equipment for the space shuttle launch site and processing facilities. From there she joined the Headquarters Air Force Systems Command staff where she was a member of the Support Steering Group for the Strategic Defense Initiative (SDI).

Beginning in 1987, she served as the chief of resource plans for the 51st Tactical Fighter Wing at Osan Air Base (AB), Republic of Korea. After that one-year tour, she returned to Wright-Patterson AFB, Ohio, to lead the SRAM II Logistics Analysis Division. She became the SRAM II deputy program manager for logistics in 1990. In 1991, Air Force Systems Command selected Lieutenant Colonel Schoonover as a research fellow to conduct this research.

Lieutenant Colonel Schoonover holds a bachelor's degree in biology and master's degrees in audiology and in systems management. Her professional military education includes both Squadron Officer School and Air Command and Staff College.

Preface

Operations Desert Shield and Desert Storm presented Air Force Systems Command (AFSC) with opportunities unique to recent history. This was the first large-scale use of the weapon systems developed, produced, and fielded by AFSC since the Vietnam War. As such, it was the ultimate proof of those systems. This was also an opportunity to provide our combat forces with the very latest in state-of-the-art weaponry, including items that had not yet been delivered when Desert Shield began. Three types of accelerated acquisitions processes contributed to this effort: upgrading already fielded equipment; accelerating the delivery of systems in development; and developing and fielding new capabilities. This paper examines the processes and procedures used in these acquisition programs and describes the lessons learned.

The lessons learned can be grouped into four areas. The first lesson is that opportunities exist to expand deliberate contingency support planning. This should be a coordinated planning effort at all levels from the program office to the command headquarters, including the Program Executive Officer organization. These plans should address the full range of acquisition activities, from the development of the acquisition and contracting strategy through participation of contractor and system program office (SPO) personnel in the contingency theater.

Second, some of the most successful accelerated acquisition efforts enjoyed close contractor involvement—including involvement at the deployed location—in the support of developmental and immature systems. Several program offices used contractors in the Gulf region, some as part of formal product support teams. The contractors' intimate knowledge of system design, operation, and maintenance procedures enabled them to make some on-the-spot modifications and repairs, improve the skill of Air Force technicians, and provide some direct operator assistance and training. In addition, the timeliness of contractor support at their manufacturing plants was ensured by the warranty and logistics support clauses that were exercised on some contracts.

The third lesson area encompasses several problem groups. They involve supply support, funding, manufacturing capabilities, and contract types. In the area of supply support, low spares levels of new or developmental systems needed special attention and handling in order to meet mission requirements. Examples were reported in which the standard Air Force handling and transportation systems could not accommodate the expedited handling required by the very low numbers of spares; that is, the normal spares pipeline had not yet been established. Neither could the standard systems track the parts of developmental systems that were not yet stocklisted. These required individual, manual handling and tracking. Problems were also experienced in the funding of programs accelerated to support Desert Storm. In general, program offices complained of confusing or insufficient funding direction. Other concerns were raised about production and manufacturing. In two instances, undisciplined access by the government to the contractor's production capabilities raised the possibility of negatively impacting his ability to support the war effort. Another

manufacturing concern was raised by a contractor. Some of that company's efforts to improve production efficiency and reduce cost would involve use of a just-in-time inventory system. Had that system been fully implemented, the manufacturer may not have been able to support or sustain the manufacturing surge requirements of an extended contingency. The last problem area highlighted concerned contracting types. Some program offices reported that fixed-price contracts can impede working relationships and effectiveness of a contractor's effort, but cost reimbursement contracts worked well. Each of these problem areas should be addressed as part of Air Force Materiel Command's (AFMC) deliberate planning, both from a command policy perspective and as part of strategy planning for future acquisition efforts.

The fourth lesson is that the effectiveness of several established processes and procedures was confirmed. Among these are many risk management techniques. Several programs used nondevelopmental items and contractor off-the-shelf systems (NDI/COTS) to minimize technical risk, cost, and schedule (DMSP, GBU-28, HAVE IPS, MICS). One program (DMSP) was able to use a fly-off strategy to demonstrate system effectiveness before providing equipment to the theater of operations. The Joint Surveillance Target Attack Radar System (J-STARS) program negotiated a not-to-exceed (NTE) contract price and schedule change to minimize the cost and schedule changes that would result from diverting limited prototype hardware to the war effort. The rapidly deployable integrated command control (RADIC) program also negotiated an NTE cost change. The value of established software acquisition procedures was also confirmed. Several of the systems that participated in Desert Storm involved software development or upgrades. One program that did not consistently apply software documentation and test standards experienced significant problems directly attributable to that deficiency. The last set of processes that was confirmed was the value of strong communication, teamwork, and customer focus. Time and again program offices cited the importance of cooperative and coordinated effort in managing concurrent schedules and in getting the job done quickly. This is consistent with the emphasis on teamwork and customer focus within the framework of the quality initiatives being implemented by the command.

In all, AFSC made significant contributions to the operations in Desert Shield and Desert Storm. Contingencies such as these are likely to occur in the future. The Air Force will once again need to develop and use the most capable weapon systems. Implementation of the lessons learned from the Gulf can enhance the effectiveness of the acquisition community in the future and help ensure continued operational success.

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Chapter 1

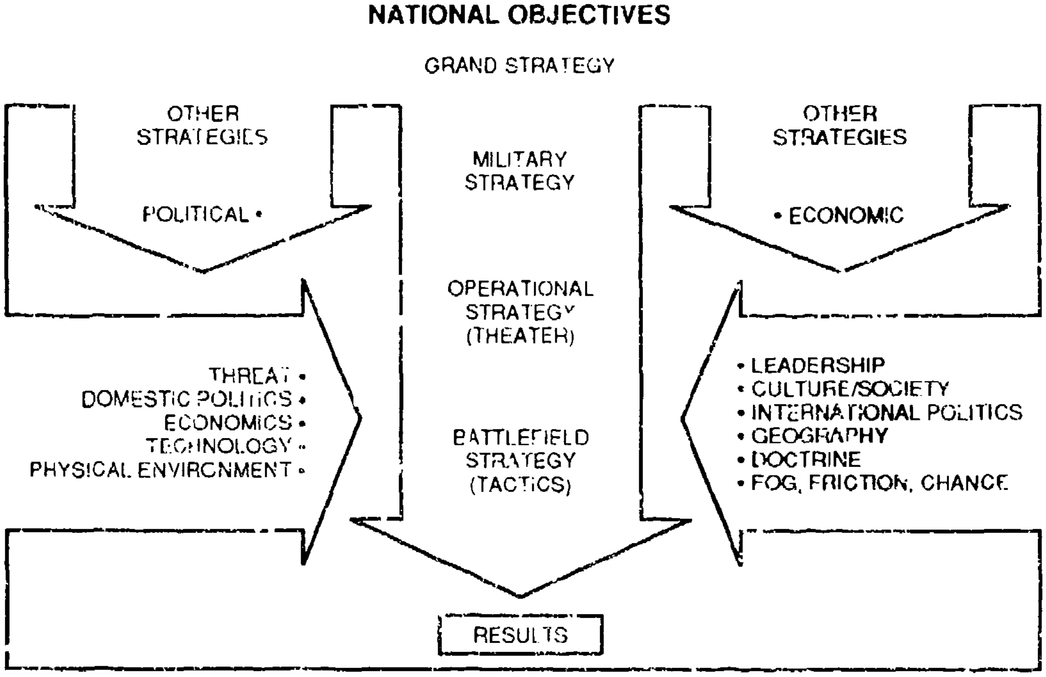
Technology, Acquisition, and War-fighting Strategy

In its broadest and most fundamental context, strategy is the decision-making process that links national objectives with the means of achieving them. Strategy has several levels, beginning with grand strategy at the national level (fig. 1). In developing strategy, it is the task of national leaders to coordinate the use of all political, economic, and military resources in the manner that best achieves the overall objective. A military option is only one of several means available to national decision makers. It is important to note that neither the decision to use any particular instrument nor that decision's implementation takes place in a vacuum. Among the many influences on both the decision-making process and its implementation are leadership characteristics, culture, politics, resources, and technology. Technology has its greatest influence at the operational and tactical levels of military strategy.[1] It is at these levels that Air Force Systems Command (AFSC) can have its greatest influence.

United States military history is replete with examples of the impact of technology on the strategy, conduct, and results of war. As soon as our country began developing an industrial base, weapons began incorporating technological improvements. As a result, the accuracy, range, and power of weapons have increased manyfold over the past 200 years. These technological developments consequently changed the scale, intensity, tempo, and cost of battle.[2] In turn, the basic operational strategy and tactics of war fighting evolved to incorporate the new capabilities that technology and industry made available.

Not only does technology enable new strategies to be formed, it enables the military to respond to other challenges. Recent years have ushered in an era of fiscal constraint and downsizing of the force. The current trend is to develop and acquire fewer new weapon systems. We have come to rely on technological solutions to multiply the effectiveness of those systems that we do acquire and to protect the lives of those who use them in this inherently dangerous profession. It has, therefore, become increasingly important to develop and field those new systems and capabilities as quickly as possible. That effort becomes urgent when war breaks out; lives and the success of the campaign are at stake.

This paper explores those new Air Force systems and capabilities whose development and delivery were accelerated in order to support Operation Desert Storm. It specifically looks at the processes that Air Force Systems Command program offices used to accelerated the fielding and support of



Source: Col Dennis M. Drew and Dr Donald M. Snow, *Making Strategy: An Introduction to National Security Processes and Problems* (Maxwell Air Force Base, Ala.: Air University Press), 1988

Figure 1. The Strategy Process

weapon systems and highlights lessons we can use to improve those processes in the future. A brief survey examines the influence of technology on the conduct of war in United States history.

Historical Perspective

The weapons technologies used during the Civil War precipitated a change in the overall strategy of the armies. Both the Union and Confederate armies began the conflict employing the traditional eighteenth-century strategy of maneuver in which large columns of soldiers marched and attacked across open fields. The introduction of the rifled barrel, minié ball, and rapid-fire Gatling gun, however, quickly increased the lethality of the conflict and drove the combatants to abandon this strategy, seeking the protection of trenches. This foreshadowed the stalemate of trench warfare of World War I.

The industrial revolution in America reached its peak in the years between the Civil War and World War I. Industry and technology thus gave World War I heavy, mobile artillery pieces and continued to develop rapid-fire weapons. "The . . . effect was to give the advantage to the defense, a phenomenon which thoroughly surprised most military planners."[3] Centuries of warfare

that had been dominated by maneuver suddenly came to an end. The efforts of combatants were stymied as they dug into defensive trenches. A stalemate resulted. Slowly the military leaders of Europe began to incorporate the new technologies into their tactics in a desperate effort to break the stalemate. The tank and the airplane provided the necessary protection and support that enabled the infantry to finally advance out of the trenches.[4] With these technological improvements in weapons, and as fresh American troops joined the battle and the military situation in Germany deteriorated, both sides were able once again to achieve limited movement on the battlefield. The stalemate was finally broken and Allied forces prevailed.[5]

The advantage of the offense returned with the technology and tactics of World War II. The two technological advances that enabled this change were mechanized armor and air power. Both were first used in World War I. During the interwar period they were advanced in design and theory, and tactics for their use were developed in exercises. The operational strategies that employed these new technologies were the German blitzkrieg and Allied strategic bombing campaigns. Both strategies advocated sweeping, high-speed maneuver, capitalizing on the surprise and aggressive offense that the new equipment facilitated. As the war progressed, however, both strategies began to show limitations. Technology and tactics to overcome these limitations continued to advance during the war, largely in the area of tactical aviation. This created problems for munitions developers, however, who had difficulty adjusting to the changes of air warfare strategy.[6] There was one technology to emerge from World War II that was to change our view of war and our strategy for almost 50 years. That was, of course, nuclear weapons and the missiles to deliver them.

Accompanying the atomic age was the evolution of the computer age. After World War II, the computers that revolutionized industry quickly found their way into military use. Weapons development once again focused on accuracy and range as well as power. The precision guided munitions (PGM) that resulted provided much of the lethal firepower in Vietnam. It has been argued, however, that these technological advances had a negative effect on operational strategy. The argument states that "the ready availability of firepower encouraged a near-total reliance on fire tactics rather than maneuverability, on outgunning rather than outthinking the opposition."[7] The counter to that argument includes the development of the Wild Weasel technology and tactics. The operational strategy here was the suppression of enemy air defenses, a strategy that finally enabled US forces to penetrate enemy air space effectively and to achieve air superiority. This same strategy continues today, and it proved eminently successful once again during Desert Storm.

The Desert Storm Experience

Our most recent experience, Desert Storm, saw the first large-scale operational use of the weapon systems developed by Air Force Systems Command

since the Vietnam era. The accuracy and range of precision guided munitions continued to improve during the past two decades. In addition, stealth technology greatly enhanced the effective delivery of those munitions. This campaign also saw the unprecedented use of space assets at every level of battle. They provided reconnaissance, weather information, navigational data, battle damage assessment, communications, and Scud missile-launch warning.

AFSC also responded to the war effort by accelerating the delivery for use in Desert Storm of many of the systems under engineering development. From the global positioning system lightweight receiver, to the joint surveillance target attack radar system (J-STARS) aircraft, to the low altitude navigation and targeting infrared (system) for night (LANTIRN) targeting pod, to the GBU-28 bunker penetrator and others, AFSC provided our fighting forces with new systems and capabilities. These technologies translated directly into tactics of Scud hunting and nighttime attacks against command and control targets by F-15Es and F-117s.

Our Desert Storm experience is consistent with our experience with technology in war throughout most of our history. Technology can bring the war to an end and save lives. It behooves Air Force Materiel Command (AFMC) to continue developing and fielding new systems as quickly as possible, especially during wartime.

Paper Organization

This paper explores the techniques and processes that Air Force Systems Command used to field systems quickly during Desert Shield and Desert Storm. It is divided into three sections. The first section describes the routine acquisition process as prescribed in Department of Defense directives. It also addresses some processes and techniques that can be used to accelerate the routine. The second section, which contains three chapters, examines those systems that were in development when Desert Storm began and whose delivery was accelerated. The last section evaluates the lessons learned from that experience and recommends actions for the future.

Notes

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2. Col Dennis M. Drew and Dr Donald M. Snow, *The Eagle's Talons: The American Experience at War* (Maxwell Air Force Base, Ala.: Air University Press, 1988), 28.

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4. Capt Robert C. Ehrhart, "World War I: Overview," *Modern Warfare and Society*, Air Command and Staff College text, 1977, 15-16.

5. Capt Robert C. Ehrhart, "World War I: Analysis," *Modern Warfare and Society*, Air Command and Staff College text, 1977, 16-5.

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Chapter 2

Weapon Systems Acquisition Processes

The purpose of weapon systems acquisition is to provide the operational user with a capable, supported, and affordable weapon system and to deliver the system when and where it is needed. Acquisition programs encompass a wide variety of development effort, from modification of existing systems through design and development of major new weapon systems.[1] All these efforts have several important concepts in common.

The first key concept is that we acquire weapon systems, not just weapons. The system includes everything that is needed to operate and maintain the weapon. In the case of munitions and airborne missiles, the system also includes any aircraft modifications or upgrades needed to use the weapon. The system includes spare parts, training and technical manuals for both the operators and maintainers, tools, and test equipment. This definition of a system to include both the weapon and its logistics support introduces another important concept: delivering to the field a capable, supported, and affordable system.

Combat capability, logistics support, and affordability go hand in hand. Combat capability not only addresses speed, range, and accuracy, but also encompasses readiness objectives in terms of availability, reliability, and logistics support. For a system of a certain required availability, the higher the reliability, the lower the maintenance and repair costs, and the better our ability to afford to operate and maintain it. This interrelationship among combat capability, logistics support, and affordability emphasizes the need to use an acquisition approach that integrates all these concepts. Air Force acquisition processes and phases are designed to ensure that this integrated design concept is followed. Let us look now at the acquisition process.

The Acquisition Process

All development programs, large or small, simple or complex, follow the same basic steps, or phases, described below.

Determination of Mission Need

Only after a mission need has been identified can a weapon system acquisition begin. Determination of mission need, however, is not a part of acquisition. Rather, it is a continuing process that precedes an acquisition program.

As stated in Department of Defense Instruction (DODI) 5000.2, *Defense Acquisiton Management Policies and Procedures,* "All acquisition programs are based on identified mission needs These needs are generated as a direct result of continuing assessments of current and projected capabilities in the context of changing military threats and national defense policy."[2] However, a determination of mission need does not necessarily result in an acquisition program. Other, generally less expensive, options are explored first. These options may include changes in doctrine, strategy, tactics, or training. Only when these other nonmateriel options cannot satisfy a need is a weapon acquisition program considered.[3]

Phases and Milestones of Acquisition Programs

There are four phases in the acquisition of a weapon syster . Each phase is preceded by a milestone decision review (fig. 2). At the milestone review, the accomplishments of a program in the previous phase and its readiness to enter the next phase are assessed. The primary document used in this review is the Integrated Program Summary (IPS). In addition to technical progress, the IPS discusses life-cycle cost and affordability, risks, and risk mitigation plans and describes the acquisition and contracting strategy that will best achieve program goals. The program review also establishes results to be accomplished during the next phase. These results are called "exit criteria" because they are the criteria that must be met to exit one phase and enter the next.[4]

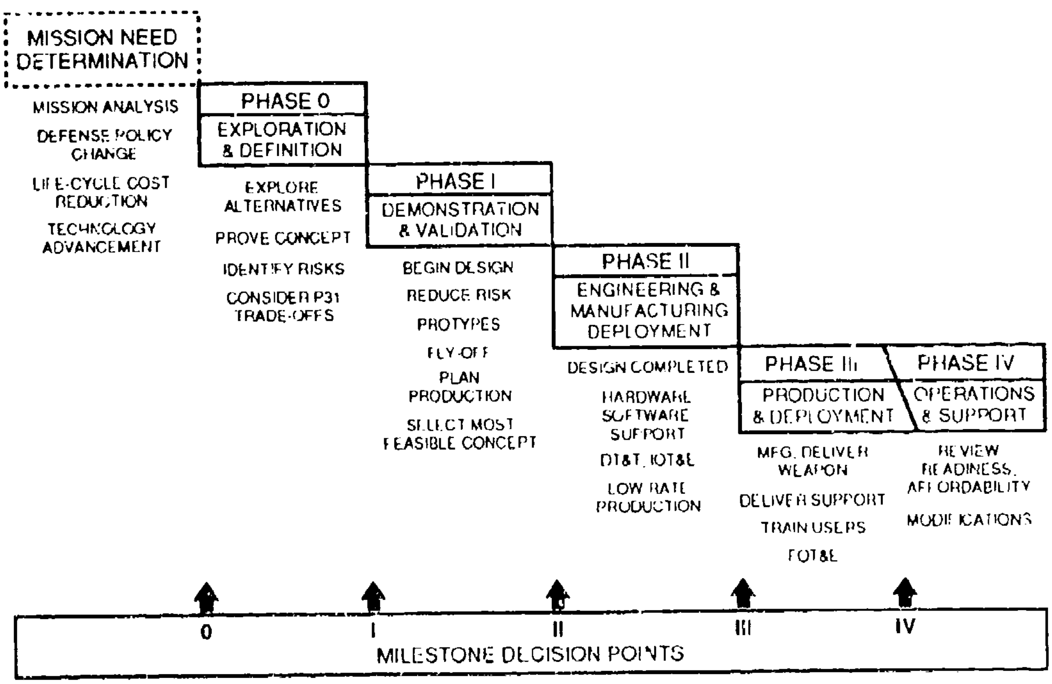

Figure 2. Acquisition Phases and Milestones

Phase 0: Concept Exploration and Definition (CE). The Milestone 0 decision marks the entry of a program into the acquisition process from the need determination process. During concept exploration, the government or contractors will conduct studies to evaluate the feasibility and relative merit of several concepts.[5] They may explore modifications to existing systems as well as new developments and the use of preplanned product improvement (P^3I). (See discussion below.) Innovativeness and competition are essential to ensure that a broad range of alternatives is evaluated.[6] Initial trade-offs are made between life-cycle cost, schedule, performance, and logistics factors. An important part of this activity is to identify the significant risk (or uncertainty) areas. For the most promising alternatives these risks are documented in the acquisition strategy. The acquisition strategy sets the stage for all succeeding phases. DODI 5000.2 requires that

> The [acquisition] strategy should be developed in sufficient detail to establish the managerial approach that will be used to direct and control all elements of the acquisition to achieve program objectives. It should include a clear description of performance, cost, and schedule risk elements and the corresponding strategies to abate those risks.[7]

As a result of the Milestone 1 decision at the end of phase 0, one or more concepts may be selected for further development during the next phase.

Phase I: Concept Demonstration and Validation (DEM/VAL). During the concept demonstration and validation phase, phase I, the feasibility of the alternatives selected from phase 0 is demonstrated. At the end of this phase, one system is selected for engineering development and initial production. During dem/val hardware is built and tested at the subsystem or system level. These tests and demonstrations may include prototype development or a fly-off competition. The objectives of these tests and demonstrations, and indeed the dem/val phase, include "defin[ing] the critical design characteristics and expected capabilities of the system concept(s)" and "prov[ing] that the processes critical to the most promising system concept(s) are understood and attainable."[8] Also critical during dem/val is a rigorous assessment of program risks and development of aggressive risk-management approaches. This is important because the Milestone II decision at the end of this phase will commit significant resources of manpower and money to the continued development and initial production of the selected system. Further, a program may not enter phase II unless it can be confirmed that projected life-cycle costs are affordable in the context of long-range investment plans.[9]

Phase II: Engineering and Manufacturing Development. Phase II, engineering and manufacturing development (EMD), may be the most complex and difficult acquisition phase.[10] The weapon and its entire support system are designed and tested during this phase, and initial production begins. A close working relationship with the user is essential and "effective risk management is especially critical during this phase."[11] The focus of EMD is to

> ranslate the most promising design approach developed in Phase 1 . . . into a stable, producible and cost effective system design, validate the manufacturing . . .

process, and demonstrate through testing that the system capabilities . . . satisfy the mission need and meet minimum acceptable operational performance requirements.[12]

Activities include design reviews of both hardware and software components at component, subsystem, and system level. Performance and reliability testing are accomplished at all three levels and include both developmental test and initial operational test. Also during this phase, plans are finalized for deployment and support of the weapon system. Initial spares are produced, technical orders are written and verified, and training courses are developed. The milestone decision review at the end of this phase carefully examines the developmental and initial operation test results. The results of low-rate initial production are reviewed in terms of performance, readiness, and sustainability (logistics) parameters achieved. A decision to proceed into full production "represents a commitment to build, deploy, and support the system"[13] for its lifetime.

Phase III: Production and Deployment. Phase III, production and deployment, begins with the decision to proceed with full-rate production. As the system is produced and fielded, support plans are implemented. The users and maintainers receive extensive training from the core of trained people who participated in the previous phase. Additional capabilities that had been deferred in a P^3I program are now implemented. In addition, "follow-on operational testing and production verification testing [will be conducted] to confirm and monitor performance and quality."[14] Data on system performance, readiness, sustainability, and affordability are compiled by field and depot units. Minor problems identified here are corrected through engineering changes while the system is still in production. Major modifications or upgrades to correct deficiencies may also be considered and are subject to a milestone review. As DODI 5000.2 states

> the intent [of Milestone IV] is that potential system modifications should compete with all other possible alternatives during a new Phase 0, Concept Exploration and Definition. . . . If a major modification program is approved, the milestone decision authority will determine which acquisition phase should be entered. This decision will be based on the level of risk, the adequacy of risk management planning, and the amount of resources to be committed.[15]

Phase IV: Operations and Support. This is phase IV, the final acquisition phase. As depicted in figure 1, it overlaps with phase III. Operations and support of the weapon system by the user begin at some point after initial units roll off the production line, when the user declares an ability to conduct initial operations. Producing and deploying the total authorized quantity of a system frequently take several years. Readiness and supportability are reviewed periodically. The effects of aging are also assessed on a regularly scheduled basis. This is particularly important for one-shot devices, such as solid rocket motors, which do not have on-and-off cycles, and for components of a nuclear circuit. Any modifications or upgrades to improve readiness or supportability, or to extend service resulting from problems identified here, follow the same procedures described above.[16]

Acquisition Management Considerations

Guiding an acquisition program through all these phases requires a thoughtful plan. This is documented in the acquisition strategy, described below. Along with this, it is important to understand who has authority to approve the acquisition strategy, and to provide direction and support to the program office.

Acquisition Strategy: Risk Management and Contracting Approach

One of the major considerations in determining how best to proceed with an acquisition program is risk management. To that end, policy laid down in Department of Defense Directive (DODD) 5000.1, *Defense Acquisition*, states that "effective acquisition planning and aggressive risk management by both government and industry are essential for success. Program decisions and resource commitments must be based on plans for, and progress in, controlling risk."[17]

There are two ways in which the contracting approach can help mitigate risk. One is for the government to develop an acquisition strategy that shares risk with the contractor. This is done by selecting "a contracting approach . . . for each acquisition phase [that] permits an equitable and sensible allocation of risk between government and industry."[18] There are two general categories of contracts used in government acquisitions: cost reimbursement and fixed price. The government bears the greatest cost risk in the former, while the contractor bears the maximum cost risk in the latter. Generally speaking, cost reimbursement contracts are more commonly used in the early stages of an acquisition program where the technical and cost risks are highest. As the system design becomes more stable and the program proceeds towards full production, technical and cost uncertainty decrease. Emphasis then shifts to use of a fixed-price contract.

Another way for the government to abate cost, schedule, and performance risk is through the use of competition among contractors. The principle works the same way as does supply and demand in the open market place, with defense contractors competing for limited defense dollars. Moreover, competition is required during all acquisition phases by federal law (Title 10, *United States Code*), by the Federal Acquisition Regulation, and by Department of Defense policy.[19]

Milestone Decision Reporting/Review Chain

The President's Blue Ribbon Commission on Defense Management in 1986 found that "federal law governing acquisition has become steadily more complex, the acquisition system more bureaucratic, and acquisition management more encumbered and unproductive."[20] In response to the latter two findings, DODD 5000.1 streamlined the reporting chain. Defense acquisition policy now

requires clear and short lines of authority and accountability. For major defense acquisition programs (defined in DODI 5000.2 by dollar expenditures), this chain extends from the service acquisition executive (SAE) through the program executive officers (PEOs) to the individual program managers (PM) (fig. 3). The SAE is the assistant secretary of the Air Force (acquisition). The PEOs are general officers who manage a related portfolio of programs (e.g., space, tactical, strategic). Program funding and daily management activity occur through this chain. Other support required by an acquisition program (e.g., personnel, technical or laboratory support, test facilities) is provided through command channels.[21] Nonmajor defense acquisition programs have a similar streamlined reporting chain, with no more than two levels permitted between their program managers and their milestone decision authority level, the designated acquisition commander (DAC).[22]

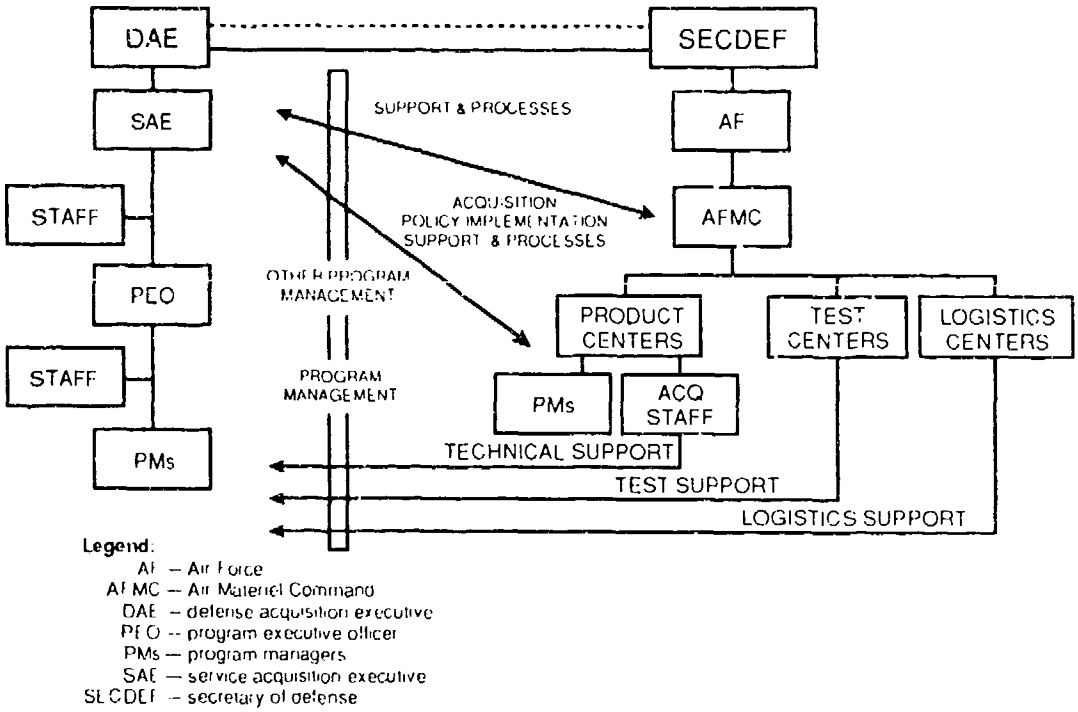

Figure 3. The Acquisition Structure

Accelerated Acquisition Processes

Recall that the initial discussion about the purpose of weapon system acquisition affirmed that it is important to field the system when the user has stated it is needed. Cost and performance parameters are carefully balanced with schedule requirements to minimize the risk of encountering difficulties. It can take six to 10 years or more to acquire a new major weapon system. Clearly, some effort to accelerate the process, while still keeping risk within

acceptable levels, is appropriate. Several methods to do that have been developed. Sole source contracting, use of nondevelopmental items (NDI), concurrency, preplanned product improvement (P^3I), and High Gear (discussed later in this chapter) are among the methods used during peacetime. In the case of a contingency such as war, it may be worth risking higher cost or initial support problems in order to hasten the deployment of an operational capability. The rapid response process (RRP) was developed to respond to just such a contingency—Operation Desert Storm.

Sole Source Contracting

In the case of an urgent or compelling need, such as war, the government may be willing to assume a greater proportion of the risk in order to expedite the development and fielding of a weapon.[23] In such an instance, a contract may be awarded to one contractor without competition. This is called a sole source contract. This can save up to 6 months or more compared to normal competitive contracting procedures.

Nondevelopmental Items

One way to reduce the time it takes to develop and field a system is to use items that have already been developed (nondevelopmental items [NDI]), but to use them in new ways. This can be done with either commercially developed items or with military hardware. The existing equipment can be used as it is, modified to fit specific circumstances, or combined with new or other existing equipment to provide a new capability. Another advantage of using NDI is that the logistics support system is also likely to have been established.

Concurrency

Another way to reduce the time it takes to develop and field a new weapon system is to overlap the phases of the acquisition cycle rather than performing them sequentially. This is called *concurrency*.

> The most common form of concurrency is the production of a system while developmental activities are still ongoing. The risk in such concurrency is that of producing a large number of units which might later prove to be unsuitable and must then be discarded, modified to be useful, or upgraded to production configuration.[24]

Schedule and cost implications of these risks must be addressed. In addition, the plan to use concurrency must be addressed as part of the acquisition strategy.

Preplanned Product Improvement

Another established method for accelerating the development and deployment of new capabilities is preplanned product improvement (P^3I). P^3I is an acquisition approach used to "reduce program risk, and speed delivery of a near-term creditable system designed for future improvements."[25] P^3I should

be considered early in the program acquisition, beginning in the concept exploration phase. It should be documented in the acquisition strategy for review and approval at the milestone decision point. The technologically difficult system requirements are deferred by using the P^3I strategy. The system that is initially fielded is designed to facilitate the future incorporation of those technologically difficult capabilities. The deferred requirements continue to be developed in parallel with the basic system and are incorporated at a later, but specified, time.[26]

High Gear

Project High Gear was established by Gen Ronald W. Yates, commander of Air Force Systems Command (AFSC), "to address a few high-priority user issues that have the potential for simple, quick solution. . . . The intent of High Gear is to satisfy users by being innovative and creative, while saving time and money."[27] The decision to designate a project as a High Gear project is made by the commander of AFSC after consulting with the user, the AFSC field commanders, and the PEO as appropriate. Each High Gear project will have a designated project manager, who will select a management team. High Gear projects will enjoy streamlined management and review procedures, similar to the PEO structure. High Gear is really an acquisition process, not a separately funded program. Thus, High Gear projects will normally operate within the confines of their normal program budget, although command resources may be made available if needed.[28]

Rapid Response Process

The Rapid Response Process (RRP) was developed to provide a streamlined process for responding to the urgent weapon system development needs of Air Force commanders in US Air Forces, Central Command (CENTAF) during Desert Storm. The process works as follows. The CENTAF commander identifies a requirement to its operator major command (e.g., TAC, SAC). The operator major command (MAJCOM) then validates the need and documents it in a Combat Mission Need Statement (C-MNS). The C-MNS is given to a special action team (SAT) at the Pentagon. The SAT

> accomplishes most of the leg-work for each [RRP] project. They review the requirement, discuss alternative solution and recommended response, pull together the acquisition approach and prepare the briefings that will be used to obtain corporate approval. . . . The General Officer Steering Committee (GOSC) . . . provides the corporate review and discipline on proposed RRP projects. It reviews potential projects to ensure the proposed solution meets operational needs and reviews the impact of the proposed funding source. . . . The GOSC sends their recommendation to [the vice chief of staff of the Air Force] for final approval/disapproval.[29]

This is normally done within 20 days. The designated acquisition command then forms a special team to execute the project. It is free to use any of the accelerated procedures described above. The project "receives priority handling and high-level management oversight (i.e., weekly status reports to

AFSC/CC by the AFSC team)."[30] By the end of hostilities in Desert Storm, the Air Force had fielded 15 systems using the accelerated procedures of the Rapid Response Process.[31]

As the remainder of this paper shows, all of these techniques for accelerating acquisition processes were used to support the Desert Shield and Desert Storm efforts. Some program offices relied on a single process, such as High Gear. Others used a combination of techniques—for example, NDI and concurrency. The following chapters review their experiences and describe the lessons they learned.

Notes

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Chapter 3

Existing Systems Upgraded for Desert Storm

This chapter begins the examination of the programs that used accelerated acquisition processes to support the war effort of Desert Storm. It addresses the High-Speed Antiradiation Missile (HARM) system whose two software upgrades encompass the modification processes undertaken during the war.

High-Speed Antiradiation Missile

One of the first missions of a counterair campaign is the suppression of enemy air defenses (SEAD). Indeed, many of the first missions flown in Operation Desert Storm were SEAD missions. The HARM was, thus, one of the first weapons used in the war. Specifically, the mission of the HARM is the suppression of hostile land- and sea-based radar-directed surface-to-air missiles and air defense artillery.[1] The HARM is air-launched from underwing pylons of the Air Force's F-4G and F-16C, the Navy's A-7E, EA-6B, and F/A-18 aircraft, and the German Tornado. The missile locks onto enemy radar emissions and homes in on them. It was reported that the HARM was so successful that after the first week of hostilities, mission packages would not fly into the Kuwaiti theater of operations without HARM support.[2]

The joint service authority for HARM is the United States Navy program office for tactical aircraft's defense suppression systems. Air Force personnel detached from the Air Force's Joint Tactical Systems program office and jointly assigned with the Navy are responsible for the development and test, production, deployment, and support of the USAF HARM inventory. The Air Force office swung into action almost as soon as Desert Shield began on 8 August 1990. Its first response was to a request from the TAC crisis action team. TAC wanted to upgrade HARM immediately to the Block III software configuration for improved target sensitivity.[3] The Block III upgrade had been in development for about three years and was scheduled to be employed in April 1991.[4] To support this immediate operational requirement, Air Force personnel assigned with the Navy directed the contractor, Texas Instruments, to accelerate delivery of the hardware needed to reprogram missile software. The rapid missile reprogramming capability developed for HARM allowed the weapon to adapt to changing enemy threat conditions with minimum effort and cost. Meanwhile, the program office assembled a reprogramming team of one officer (an engineer), two noncommissioned officers (munitions maintenance specialists), two Navy civilian tech-

nicians, and contractor personnel. The team deployed within three days of notification and began reprogramming missiles.[5]

Soon after the reprogramming effort started, another software problem was discovered. The HARM was locking on some coalition radars (Soviet and French built) and would not lock on United States systems the Iraqis had captured.[6] Obviously a software modification to the targeting file was needed. Texas Instruments began working a three-shift operation to develop the software and to deliver retrofit kits.[7] The success of this and the previously described reprogramming efforts were heavily dependent upon support of the munitions maintenance people in each theater. The reprogramming operations were given priority and worked on two 12-hour shifts, seven days a week. Before the start of Desert Storm, all missiles in the theater had been reprogrammed. By the end of "March 1991, all missiles in the Air Force inventory were reprogrammed. Over 6,000 [Air Force HARM] missiles at more than 9 locations worldwide were reprogrammed in 7 months, more than 2 years earlier than originally planned."[8] The Air Force-led team also reprogrammed HARMs for the United States Marine Corps air group flying F/A-18s and based in the West Asian theater.[9]

Then in January 1991, with the start of Desert Storm, the HARM program office once again had the opportunity to show its mettle. Early in the war, the F-4Gs experienced more HARM jettisons than expected.[10] This was a problem not only because of the loss of HARMs but also because there was only a limited number of launchers available. In addition, two of these aircraft came back with rocket motors expended and five came back with expended batteries.[11] In response, a USAF/contractor tiger team consisting of USAF HARM program office personnel, and aircraft, missile, and missile rocket-motor contractors deployed to Saudi Arabia to investigate the problem.[12] "The team consisted of personnel from the rocket motor, aircraft, and missile contractors and was led by the SPO [system program office] senior officer (ASD/YJ)."[13] The teams found that the hangfires occurred only on certain aircraft. They also found that the crew left the multistation select switch on after performing the built-in test (BIT). This allowed accidental enabling of the last missile tested. They concluded that the most likely cause was variability in the F-4G relay switch along with multistation selection by the pilot. A procedural workaround was developed in the field to fix the problem. It included avoiding use of the multistation switch.[14] In a parallel effort, a launcher procurement program was initiated in the event an easy solution was not found. The aircraft problem has been verified as an F-4G-specific software problem.[15] Although a software rewrite was prepared, TAC decided that installing the software fix was not cost-effective because the F-4G will be phased out of the inventory soon. Instead, TAC implemented the procedural fix.[16]

Lessons Learned

Teamwork and cooperation among the Navy-led program office, Air Force agencies, and contractors were excellent. Navy contracting officers aggres-

sively processed the contract changes needed to implement the software upgrades. HARM testing was conducted at a Navy installation.[17] Further, during the 10 years the HARM has been in production, the contractor has never missed a delivery schedule and can boast one of the best learning curves in the industry. Over that time, the program office, contractor, and user have developed a close team relationship. Efforts expended during this time to support the user act as a foundation of trust and enhance the quality of the product. They aid in better understanding the user's requirements and in fashioning test programs that realistically reflect wartime scenarios.[18] In addition, this solid base of teamwork made it easier to correct problems that surfaced during Desert Storm.[19]

It is important to ensure that every detail of testing accurately reflects the way the system will be used in combat.[20] Missing even the smallest detail (e.g., selection of multistation switch) can lead to lost missions and costly efforts to correct the problem.

Direct communication between deployed units and the program office via secure STU-III telephones and fax was extremely useful. It enabled timely and accurate discussion of problems and enhanced the contractor's ability to provide solutions to combat problems quickly.[21]

"One of the biggest leverage elements to the entire HARM program and the Desert Shield/Desert Storm events is the fact that the Air Force places outstanding [noncommissioned officer] NCOs with related field experience in the program office."[22] These NCOs made significant contributions, both in the program office and with the deployed team, in identifying causes of problems and in developing and implementing the corrections.

Notes

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Chapter 4

Systems Whose Development Was Accelerated for Desert Storm

Having examined fielded systems that were upgraded and modified to support Desert Storm, we now turn our attention to systems that were under development when Desert Storm began. Some, like the F-15E and low-altitude navigation and targeting infrared for night (LANTIRN), had begun being delivered to some units, but they had not reached initial operational capability and did not yet have full logistics support established. Other systems, like J-STARS, were several years away from initial planned delivery when they were deployed to the Gulf. Let us begin with the F-15E.

F-15E

"We did our fair share of taking out Iraqi bunkers, Scud missiles, and tanks. I think the airplane worked quite well." That is how Lt Col Pete Deibig describes the success of the F-15E Strike Eagle during Operation Desert Storm. Colonel Deibig led a team from the F-15 System Program Office (SPO) at Wright-Patterson Air Force Base's (AFB) Aeronautical System Division. The team accompanied the 4th Tactical Fighter Wing to its deployed location. The SPO team was a critical element of the Strike Eagle's success during the war.[1]

The F-15E is a dual-role fighter, able to perform both the air superiority and interdiction roles. It has the same air-to-air capability as other F-15s, but has improved avionics and a strengthened airframe for air-to-ground bombing.[2] Its primary mission is air-to-ground interdiction, and it fought solely at night during Desert Storm using the LANTIRN system.[3]

The F-15E program began in 1984 when it was selected to satisfy the mission of dual-role fighter. Flight testing began in 1986 and initial deliveries were in 1988.[4] Because of the high degree of concurrency in the program, initial operational test and evaluation (IOT&E) was still under way even after the program was well into production, and the Strike Eagles were already being deployed to Saudi Arabia.[5] New aircraft systems normally have several months or years in which to mature, to work out the bugs after IOT&E. The Strike Eagle was not to have that luxury.[6]

The decision to commit the F-15E to a combat role in the Gulf came in August 1991. Only 18 months after receiving their first aircraft, the 4th

Tactical Fighter Wing (TFW) deployed. Two months after achieving fully operationally ready status, the 336 Tactical Fighter Squadron (TFS) deployed. The 335 TFS followed suit soon thereafter, only nine months after their first F-15E flight.[7] Because system test was not yet complete, and because full logistics support was not yet in place, this was quite a feat.

To help overcome these limitations, the F-15E SPO assembled and operated a dedicated team, called the Desert Eagle Team. The team operated from their normal home locations. It included representatives from all SPO directorates, plus key players from McDonnell Aircraft Company, the prime contractor (also known as McAir) and their subcontractors, the system program manager's office at Warner Robins Air Logistic Center (WR-ALC), Headquarters Tactical Air Command (TAC), the LANTIRN and engine SPOs, and the Tactical Air Warfare Center (TAWC), among others. Of these, WR-ALC, McAir, and the LANTIRN SPO also developed dedicated teams to address specific issues as they arose. Although this team expedited support to the deployed unit, closer contact was still needed. On 13 December 1990, with hostilities looming on the horizon, a "tailored [Product Support Team (PST)] of SPO personnel was built and deployed with the operational unit to support both F-15E-peculiar and LANTIRN issues. Again, these included both USAF and contractor participants. . . ."[8] The deployed SPO PST worked closely with aircraft maintainers, expediting parts deliveries and working out engineering problems.[9] Field Service Representatives (FSRs) from McAir also deployed to Saudi Arabia as integral members of the PST, and they were instrumental in accomplishing repairs normally beyond the capability of base-level maintenance.[10]

In addition to supporting the F-15Es that had already been delivered and deployed, the F-15 SPO received several requests to enhance the Strike Eagle's interdiction capabilities. As reported in *Leading Edge*, "these included increasing the accuracy of bombs, and using several combinations and placements of bombs, missiles and external and conformal fuel tanks to extend range and missions."[11] These efforts were completed successfully and included 82 test flights performed by the 3246th Test Wing at Eglin AFB.[12] To further enhance F-15E capabilities, the SPO "accelerated weapon system certification for selected armaments. Testing had been previously planned. . . but was reordered to ensure F-15Es in the Mideast could use specific weapons in combat."[13]

All this resulted in Strike Eagle performance that exceeded stated user requirements during the war. They maintained a 95.5% fully mission capable (FMC) rate throughout the conflict.[14] This is remarkable not only because the aircraft was new but also because the conditions were more severe than usual. Lt Col Deibig explains.

> The whole war went against normal training. At home you crank out the sorties, fly at low altitude, drop your bombs, and head home. In this war, there were fewer sorties which lasted much longer, up to 5 or 6 hours. Some sorties lasted nine or 10 hours because local sand storms, called "shamals," prevented landing. The airplanes also flew at medium rather than low altitude to avoid Iraqi defenses[15]

In all, during Desert Storm the F-15Es flew 2,185 combat sorties for 7,359.7 combat hours, and delivered 11,270,620 lbs of munitions.[16]

Lessons Learned

Product Support

Product support is an extremely important part of acquisition strategy. It consists of product support teams, supply support, and spares.

Product Support Teams. Should future contingency operations require the deployment of newly operational weapon systems, dedicated teams from USAF and key contractor groups should be formed in the CONUS. In addition, a tailored product support team should be formed and sent to the deployment location.[17] These teams should be given liberal authority to respond directly to the user, both in the field and at the appropriate headquarters, whenever possible. This is the approach successfully used by the Strike Eagle team. From the dedicated product support teams deployed with the user, to the integrated Desert Eagle team at home, everyone worked together to support the war effort.

In addition, the deployed team should include a senior NCO with appropriate aircraft- or munitions-maintenance background. Although the deployed team greatly enhanced SPO and user communication, some problems were still encountered. Some of these problems could have been averted had the deployed team included a maintenance NCO. Captain Mason explains.

> On several occasions, the descriptions/circumstances of problems encountered by deployed maintenance personnel were not communicated to the proper CONUS personnel nor, when communicated, were they explicit enough to effectively analyze and solve the problems. . . . We could have resolved problems faster and more completely with better field information. Because reports were sometimes incomplete and/or misleading, SPO logistics personnel often interpreted problems incorrectly, which led us to waste valuable time and effort.[18]

Supply Support. A method for expediting spares support must be established as early as possible during a contingency and clearly communicated to all parties. This is a special requirement for developmental or immature systems when the routine supply system is not yet in place. It must include a single point of contact to pass on urgent operator support requirements to contractors and suppliers, including subcontractors and USAF logistics support elements.

This lesson is the result of several problems encountered during Desert Storm. The supply support system was not fully in place when the F-15E deployed. For that reason the deployed unit telephoned the SPO to request spares support identical to that which had also been entered through normal requisitioning channels. Yet often the item managers were unaware of the needs until contacted by the SPO because the requisitioning data had never been transmitted from the deployed location into the automated CONUS sys-

tem. In addition, contractors and/or suppliers often received conflicting and/or overlapping requests for spares, and contradictory shipping instructions for repaired assets. Coordination between the SPO and air logistics center (ALC) often took place after the requirements were already passed. Lastly, direct communication between the operator and the subcontracted suppliers sometimes created accountability problems for the prime contractor.[19]

Spares. The quantity of spares to support contingency operations was inadequate and needs to be improved. The F-15E suffered from two problems. First, initial provisioning of spares was lower than needed. Second, sporadic funding of war readiness spares kits (WRSK) resulted in deficiencies in some kits when the order for deployment came in August 1990. (It is important to note here that these problems concern only the F-15E. Those items common with the other series F-15s did not suffer these problems.)

The initial provisioning shortfalls resulted from two causes. The provisioning levels were calculated with mature maintenance usage and reliability rates rather than by using the higher rates expected with immature systems. Perhaps more importantly, the actual field reliability rates were lower than predicted rates.[20]

Although not an acquisition problem per se, inadequate WRSK is nonetheless a very real problem to a deployed squadron. This is because WRSK is the primary source of spares support during deployments. WRSK was fully funded in fiscal year (FY) 1987, but not funded at all in FY88 or FY89.[21] Deficiencies in WRSK can result in lost sorties.

In all, "Spares planning should take weapon system concurrency [and the possibility of a contingency] into consideration. . . . Given the decreasing flexibility and surge capability of producers, adequate spares posture [to include WRSK] is the only guarantee of sustained support for . . . concurrent systems." (ASD/VFE) Inadequate spares can easily lead to lost sorties during a contingency.

Teamwork, Customer Relationships, and Communication

Teamwork, close customer relationships, and frequent communication emerged as important keys to the accomplishments of the F-15E in Desert Storm. The effectiveness of teamwork is illustrated by this example described by the F-15 deputy program director.

> Virtually all tasking from the TAF, including all elements of HQ TAC and CENTAF (deployed), came directly to the SPO, often through the deployed PST. On no occasion was tasking routed through the battle staffs at HQ AFSC or HQ ASD. This meant that the SPOs became key operational support elements, often providing support both directly to the deployed wing, and to the deployed wing through the 4 TFW at Seymour Johnson AFB.[22]

On the other hand, all team members need to understand the limits of their authority. In the excitement of close teamwork and constant communication, a team can inadvertently skip an essential step and consequently slow the

process down. Such was the case when the appropriate decision and resource allocation authorities were omitted from an action.

> Improper routing of 4 TFW (Provisional) requests for enhanced/modified operational capability engendered delays and inefficiencies. . . . Many requests for flight clearances and weapons support from 4TFW (Provisional) were phoned directly to the SPO, Eglin, or McAir without the knowledge or approval of HQ TAC/DRF/DRA. Commitment of scarce resources required HQ TAC approval. However, because its decision makers had been excluded from the original communications requesting assistance, HQ TAC declined to provide clearance until after additional reconfirmation from the 4 TFW (Provisional). ...Although the intent was to speed up the process, it turned out that by-passing HQ TAC actually slowed it down.[23]

A more efficient approach would have been for the 4th TFW (Provisional) to work simultaneously with both the SPO and with their chain of command through CENTAF. In this way, the action agencies (SPO, test wings, contractors) could have begun appropriate, preliminary analysis and planning while command authorities decided priorities and resource allocation.

Lastly, adequate communications links between deployed forces and SPO are essential, both telephone and fax. Tracking and expediting parts was a real problem until AT&T installed satellite dishes and telephones.[24]

Contracting

The production contract should define the contractor's role and responsibilities in case of war before initial fielding is complete. This flexibility can be provided in the form of priced options or clauses and should be part of the initial acquisition strategy. Although all the contractors were responsive to the urgent needs of wartime, the contractors were unwilling to send field service representatives to the deployed location until they had an appropriate contractual vehicle in place. That was a perfectly reasonable position for them to take, but it is one that can delay effective support to combat operations. In addition, the SPO used many undefinitized contract actions (UCA) to authorize such activities as borrowing production assets for use as spares and certain aircraft modifications.[25] UCAs expose the government to uncontrolled contractor costs and can be a risky way of conducting business.

Funding

Funding procedures for contingency procurements need to be clarified. Managers in the program office found funding for deployment support of the F-15E confusing and inadequate for procurement appropriations. They expected procurement direction to also include funding of production assets. Ms Miniard from F-15 program control explains:

> While the [Rapid Response Process] provided funding and authority for Theater Commander in Chief requests, the F-15 SPO was asked to address numerous needs identified by the operators at the wing level. When we requested additional . . . funding, [we were provided] generalized authority to execute Desert Shield/Storm activities using existing direction and funding.[26]

In addition, the FY91 Supplemental Appropriations that provided funds after the conclusion of hostilities, funded operations and maintenance only and "did not replace the amounts which F-15 SPO used from existing budget authority."[27]

Priorities

The Air Force needs to maintain discipline and not abuse the contractor's priority system. The F-15 SPO production chief confirms[28] that the "Desert Shield/Storm Project Code was misused, resulting in premium effort being applied to non-critical activities. USAF agencies used Desert Storm as an opportunity to fix support problems not related to Desert Storm (evidenced by requests for spares/repair expedites from lower priority operating units.)"[29]

Production/Manufacturing

Although McDonnell Aircraft Company was responsive to government requests, cost reduction moves by McAir and by other industry leaders may have a negative impact on future contingency spares support. McAir is acting to reduce manufacturing costs by switching to a just-in-time inventory. They expressed the concern that if that system, as well as other work-in-progress reductions, had been in place, they would not have had enough assets to support Desert Storm requirements.[30]

Government and contractor cooperation expedited aircraft deliveries. The Defense Plant Representative Office (DPRO) and McAir inspectors performed simultaneous inspections at the end of the production line. The result was critical days eliminated from the delivery schedule.[31]

Planning

Formal planning should be accomplished on two levels: at the command headquarters and at the program office.

At the MAJCOM level, Headquarters Air Force Materiel Command (HQ AFMC) should create an annex for contingency operations in their war and contingency support plan. It should identify those systems in the production and deployment phase that could be used during a war. This list should be updated annually. For all systems identified in the HQ AFMC plan, the program office should establish more detailed plans (see below). HQ AFMC should further work with the using commands to establish plans for the beddown and support of deployed product support teams.

In the program office, contingency support plans should be documented no later than the start of low-rate initial production. This should be done by both the government and contractor and can be done as part of the production plan. The plan should "identify risks of going to war at IOC with immature weapons system. Plan for systems to go to war at IOC and identify shortfalls: subsystems, qualification testing, integration, spares, quantities, repair capabilities, WRSK."[32] It should address spares, training, contractor and depot support. The plan should contain a war and mobilization section that specifi-

cally names deployment team members, both Air Force and contractor. This section should lay out team support requirements, to include telephone and fax communications with the program office, communication chain and authority, and operations procedures. Lastly, the contingency plan should also "establish contracting procedures, emergency funding procedures, production hardware and loan/payback procedures for war time support."[33] (Also see contracting lesson above.)

In all, the command should develop and implement a thorough contingency support planning system that includes detailed plans in the program offices and top level plans at the command level that are coordinated with the operating command's war plans.

Low-Altitude Navigation Targeting Infrared for Night

When Desert Shield began in August 1990, the LANTIRN was one of the first systems to deploy. Because it is used with both the F-15E Strike Eagle and the F-16C/D, the LANTIRN system was deployed with the 4th TFW, the 347th TFW, and the 388th TFW. In all, the system flew over 14,000 combat hours.[34] In addition, the F-15E fought exclusively at night using the LANTIRN system.[35]

LANTIRN is a two-part system made up of a navigation pod and a targeting pod. The AAQ-13 navigation pod houses a wide-field-of-view, forward-looking infrared (FLIR) and a terrain-following radar. The AAQ-14 targeting pod interfaces with aircraft controls and displays and its fire control system. It provides semiautomatic target acquisition and delivery of unguided and guided weapons. The targeting pod can also be configured for designator use only with laser-guided munitions.[36]

What makes this remarkable is that delivery of the targeting pod had begun only two years earlier. Only twelve pods had been delivered by August 1990.[37] LANTIRN deliveries were not scheduled to be complete until 1992. More importantly, the targeting pod had not yet reached its initial operational capability when the order to deploy was received. In fact, it was inserted directly in combat for some aircraft.[38] That means the logistics system was not yet in place: the full complement of spares was not available and technical orders were not completely validated. Further, the targeting pod was still an immature subsystem, still working out some of the initial problems. In order to preclude combat problems that could arise from this situation, a product support team was deployed to the 4 TFW (deployed) location to fill gaps in organic maintenance capability and logistical support. In all, the LANTIRN targeting pod exceeded its expected fully mission-capable rate[39] and contributed significantly to the success of the F-15E Strike Eagle.

Lessons Learned

Teamwork

The key to effective use of an immature system in a combat situation is a product support team (PST) deployed with the user. The LANTIRN program office built and deployed a tailored team composed of both SPO personnel and contractors. The contractor team members are particularly important because "many problems required hands-on experience similar to those learned by the contractor support engineer/technician during various systems test."[40] Neither SPO nor tactical air force (TAF) people had this valuable experience. Only the dedicated teamwork of the combined team made the accomplishments of the LANTIRN system possible.

Product Support

Jack Wilson, the deputy program director for LANTIRN, succinctly stated their most important lesson from Desert Storm, " To ensure a smooth transition of an immature system from an acquisition system directly to a combat situation we believe that it is imperative to have contractor support at the AOR [area of responsibility]." The team deployed during Desert Storm performed many critical maintenance and operations support tasks. Most significant to the war effort, they prevented the loss of numerous combat sorties.[41]

Maintenance Support. The LANTIRN targeting pod was deployed before the TAF possessed its first fully capable targeting pod squadron. Although trained Air Force maintenance personnel were deployed, their maintenance experience was limited. Contractor support engineers and technicians filled the gaps in organic maintenance capability and logistical support. They were part of a PST deployed to the 4th TFW (deployed) location from 2 January 1991 to early June 1991.[42]

The 4th TFW/MA (deployed) termed the support provided by the PST as "invaluable." In addition to augmenting organic capability, the team provided a depot-level type maintenance capability at the deployed location. In five separate instances, it was this depot-level maintenance which prevented pods from being shipped off station for repair and precluded possible lost sorties.[43]

Supply Support. Expedited supply support and direct lines of communication between deployed units and stateside experts were key links in support of LANTIRN, especially the targeting pod.[44]

The targeting pod was deployed as an immature system with limited spares. To maximize use of the spares available, the program office and air logistics center initiated actions to expedite the established supply system. These actions included providing contractor support on the PST in the theatre, maintaining direct communication with the field through daily telecons, establishing a courier service to ferry critical repairable items directly to depot, and accelerating requisitions directly to the depot. In addition, the PST

identified high-failure components so that spares stockage levels could be increased.[45]

Other Support. The contractors deployed with the PST provided other critical support as well. For example, because the targeting pod was still immature, intermittent built-in-test (BIT) faults had not yet been corrected. Under certain conditions, the BIT exhibited false positive indications.[46] The contractor was able to draw upon engineering development experience to design procedural enhancements and workarounds that alleviated this problem. They also trained aircrews in-theater by reviewing tapes and providing academic instruction. Lastly, they clarified technical order procedural items in both aircrew and maintenance manuals.[47]

Contracting

A warranty clause and an interim contractor support clause for depot support were already in place on the LANTIRN contract. They enabled the rapid return and repair of spare components.[48] These clauses should be considered for inclusion in production contracts that plan for the support of contingency operations.

Joint Surveillance Target Attack Radar System

The first six weeks of Operation Desert Storm were dominated by Air Force missions. Most of the targets were on the ground, especially armored vehicles and Republican Guard strongholds. This was an ideal environment in which to use the new joint surveillance target attack radar system (J-STARS). J-STARS is a modified Boeing 707 that uses a phased-array antenna to detect targets beyond line of sight.[49] It can "detect, classify and track moving or stationary vehicles over a large battlefield and transmit that information to Army and Air Force commanders in real time"[50] via a secure data link. J-STARS can perform its mission during day or night, under most weather conditions, and in electronic countermeasures and air defense environments.[51] It complements the airborne warning and control system (AWACS), which tracks airborne and ocean-going targets; AWACS is also a modified Boeing 707, with the familiar radar dome on top.[52]

J-STARS was a developmental system approximately four to five years away from initial operational capability (IOC) that was called to active service during Desert Storm.[53] Software was still in development, and the only hardware available was prototype hardware.[54] In the fall of 1990, the J-STARS had completed a successful operational field demonstration in Europe.[55] The purpose of that demonstration was to give the users in Tactical Air Command (TAC) an opportunity to preview the J-STARS capabilities so that they could refine their operational requirements and refine their concept of operations.[56] Following this successful demonstration, Central Command became inter-

ested in its use in Desert Shield and General Schwarzkopf, commander in chief, decided to deploy J-STARS.[57]

On 18 December 1990, the program office received the order to deploy the J-STARS system and the 4411th Joint STARS Squadron formed.[58] By 24 December 1990, the program office awarded a letter contract to prepare the aircraft for deployment.[59] Shakedown test flights began immediately at the contractor's facilities in Melbourne, Florida.[60] Meanwhile, the program office prepared a contract for a 60-day deployment and support of J-STARS.[61] It was awarded on 10 January 1991. Two E-8 J-STARS aircraft deployed the next day. In less than one month, the squadron had been organized and trained to operate the aircraft and the sensors on board. It flew its first mission on 16 January 1991, the day before hostilities began.[62]

Lessons Learned

Program Management

The user should be prepared for a delay in the final delivery schedule of a system when it is used during the development period. Joint STARS was deployed for a total of 55 days. "However the pre-deployment preparation by the contractor, the loss of two test assets for the deployment period, the contractor shifting gears from FSD to deployment support and back again, and the refurbishment of the aircraft have caused a projected program [delivery] schedule slip 6–7 months."[63]

The information gained during this period, however, may more than offset the time delays. The deployment can be considered a period of operational field testing. The program office gets a better idea of what areas need to be focused on during development, and the user gets a chance to examine and refine his operational concepts years before he normally would.[64]

Contracting

Although the urgency of a contingency operation may necessitate the use of an undefinitized letter contract, it is important to specify as much as possible in the original agreement. For the J-STARS effort, the program office was able to define all contract activity, except final cost and schedule changes, in the initial letter contracts. The lessons-learned point paper written by the program office describes their actions.

> Due to time constraints and the urgency of the requirement, an undefinitized letter contract (cost plus fixed fee) was required in order to provide for contractor support of the deployed development system. However, in spite of this urgency, the program office was able to prepare and issue a contract document that included a complete definitized work statement as well as contract terms and conditions (including all applicable FAR [Federal Acquisition Regulation] and FAR Supplement clauses). A not-to-exceed (NTE) contract value was also agreed upon. As a result, the only undefinitized aspect of the deployment contract was the final negotiated price. In addition, . . . concurrent with the award of the deployment contract, a contract

> change should be issued addressing the cost and schedule impact to the development contract. This was accomplished with a bilateral change order that included an NTE [not-to-exceed] price impact and a NTE schedule delay.[65]

The cost reimbursement feature of the deployment contract change fostered a close working relationship between the contractor and government personnel. The basic development contract is a fixed-price contract, and the contractor was in an overrun situation.[66] Contractors in this situation frequently use less than optimal problem-solving techniques. The cost reimbursement structure for deployment allowed the contractor to put aside financial concerns and concentrate on providing needed capability to the war effort.

Funding

In addition to immediate funding problems for the contingency effort, schedule delays cause funding problems in future years. In their initial lessons learned report, the program office stated that

> The Joint STARS program office funded the entire deployment effort from program funds [3600] as no 3010 [production] money was available. This created a serious shortfall. As it stands without a supplemental appropriation, the program may run out the budget prior to the end of the fiscal ear. The lesson here is: If possible, know where our money is coming from before you depart.[67]

As events unfolded, the Supplemental Appropriation passed by Congress to pay for the Desert Storm actions did fully reimburse the program office for the deployment. However, the schedule changes caused by the deployment resulted in funding shortfalls in future years. For example, some work originally scheduled to be accomplished in fiscal year 1992 has been changed to fiscal year 1993. There is inadequate money programmed for that year to cover the new amount of work.

Planning

Air Force Materiel Command should establish a structured system to plan for future deployments of systems prior to their initial operational capability. This system should address not only contracting and funding issues, but should establish a mobility program for both government and contractor personnel. The program lessons-learned paper suggests that

> adequate protective gear, training and in-country support need to be planned for any contractor personnel in a hazardous situation such as this. In addition, such things as additional compensation, insurance, wills, and family support must be addressed.[68]

Product Support

Product support depends upon three entities: spares, maintenance, and transportation. The following paragraphs illustrate the interrelated complexity of those three requirements.

Spares. The deployment of a system still in the engineering development phase causes special supply problems that should be addressed in a contin-

gency support plan. Joint STARS had spares requirements that exceeded the military's and manufacturer's ability to meet in several instances. J-STARS did not yet have depot support or a supply system in place. In addition, some vendors were not ready to handle the volume of spares required by an operational system in combat. Since J-STARS are modified Boeing 707-series aircraft, they were able to share supplies with the AWACS supply point in Saudi Arabia and make use of an established commercial 707 support system. However, in some instances, only two line-replaceable units (LRU) existed. While one was on the aircraft, the other was in transit to and from a repair site.[69]

Maintenance. Maintenance and support operations of a prototype system in a contingency situation is dependent upon contractor support. The logistics support system is still in the early planning stage during engineering development. The contractor, Grumman, maintained the J-STARS aircraft and manned a number of the key positions on the mission crew. Joint STARS also had an on-site engineering capability that allowed them to perfect software and do postmission data processing.[70]

Transportation. Spares for developmental systems have special handling and transportation requirements. They are not yet stock listed, so the supply system does not easily facilitate assigning them a high priority. Yet there are so few of these spares that they cannot be allowed to follow routine handling procedures. Lastly, they may be coming directly from a contractor rather than from the government supply system. As a result of these conditions, the J-STARS program frequently chartered aircraft to get unique spares to the MAC aerial ports.[71]

Return to Peacetime Development

System strengths and weaknesses that are learned during a contingency scenario must be systematically incorporated into the system's acquisition program. The Joint STARS Program Office has a program called the capability analysis program (CAP) that consists of taking all of the inputs from the Desert Storm participants and compiling them into various categories, considering whether they are already part of the full-scale development (FSD) program, part of the 3d Aircraft Program (follow-on FSD), or should be part of the preplanned product improvement (P^3I).[72]

NAVSTAR Global Positioning System

The NAVSTAR (navigation satellite timing and ranging) global positioning system (GPS) has been an ongoing program at Space Systems Division for many years. GPS suddenly found itself in the spotlight in January 1991 when operations in the desert began. Its use during Desert Storm was particularly important because the featureless desert environment provides few navigation and location cues, whether on land or sea or in the air. The GPS overcomes these problems by providing precise position, velocity, and time

information anywhere in the world and during most hours of the day.[73] It is credited with guiding Army helicopters on their first raid against Iraq's early warning radars, with enabling a successful rescue of an F-16 pilot downed behind enemy lines,[74] and the just-in-time close air support to an Army fire squad pinned in a ravine by Iraqi troops.[75] In fact, all units contacted by Headquarters TAC/DO adamantly asserted that mission effectiveness would have been substantially degraded without GPS.[76]

The GPS user segment was the focus of acquisition activity during operations Desert Shield/Storm. It consists of three types of satellite receivers: a portable 17-pound, one-channel set for personnel and surface vehicles; a two-channel set for helicopters; and a five-channel set for fixed-wing aircraft, submarines and large surface ships.[77] Full military specifications call for 16-meter accuracy with selective availability and antispoof capability. During Desert Shield/Storm, the small lightweight GPS receiver (SLGR) was procured and delivered to the field as a hand-held set. The SLGR is a commercial GPS receiver weighing only about 4 pounds. It meets the "military temperature, shock, vibration and moisture requirements . . . but lacks the accuracy and antijam capability of full military sets."[78] Desert Storm began with several hundred GPS receivers in-theater.[79] It ended with 6,300, of which about 4,800 were SLGRs.[80]

The Joint Program Office employed a variety of techniques to accelerate its acquisition processes and field SLGRs quickly. The one that had the largest effect was the fielding of commercial equipment, which required no development effort. The primary impediment to this method was a requirement by assistant secretary of defense, command, control, and intelligence (ASD/C^3I) to procure only military sets capable of secure transmission. Because the commercial sets do not have this capability, each service wanting the SLGR had to get a waiver of this requirement.[81]

Another technique the JPO used to expedite the contracting process was modification of the existing Trimble production contract to add delivery contract line item numbers (CLIN) rather than competing and awarding new contracts. Three separate letter contract modifications were awarded between 31 August and 18 December 1990 in order to accommodate the numbers required by ground forces.[82]

The rapid response process was used in procurement of small lightweight GPS receivers. This proved to be invaluable in expediting the reviews needed to award legal contracts. For example, the justification review document for one of the contracts was completed and coordinated in just one day, far faster than the usual few weeks.[83]

Lessons Learned

One of the concerns expressed by the deputy commander for operations, Air Force Space Command (AFSPACECOM/DO) was that we need to place more

emphasis on the user interface and user capability aspects of the systems we develop and deliver.[84] This sentiment was echoed by the program office:

> Within the past four years, the integration of GPS on frontline aircraft has gone from having almost 100% of the aircraft integrated by 1998 to approximately 25%. The greatest lesson we could learn is to fully fund the programs providing the greatest benefit.[85]

The rapid response process was invaluable in expediting paperwork through all levels.

Because the Air Force had negotiated firm, fixed-price contracts, new contract prices had to be negotiated with each change. A more direct contracting method may have been to use a delivery order contract, which would specify a minimum and maximum order, maximum monthly order, and a price schedule. In this way, the time required to receive bids and negotiate prices on the three separate actions could have been reduced.[86]

The program office, with the help of the DPRO, must maintain visibility into the contractor's manufacturing capabilities and status. The program office reported:

> Even though a single, central procuring office was established (the JPO), some organizations ordered receivers through their own contract. This proved to be more costly in terms of unit cost and reduced warranty. It also caused a problem for the JPO due to overall requirements, unknown to the JPO, exceeding production capability.[87]

It was also reported that there were numerous individual credit card purchases by military personnel in the Gulf.[88]

It is imperative that program offices remember that their charter is to deliver a capability, not pieces of equipment. Colonel Runkle, former program director of the NAVSTAR GPS joint program office, reports:

> Many of the troops wrote letters to the contractor stating they loved their GPS equipment, but why didn't they have manuals, external antennas, or "AA" battery packs or longer cables, or carrying straps, or. . . . It became very apparent that items such as manuals, external antennas, carrying straps, etc. need to be procured and delivered in parallel with the prime equipment.[89]

Command and Control Information Processing System, Military Airlift Command

Desert Storm has been called a logistics war.[90] Indeed the logistics operations broke every logistics record set during World War II, Korea, and Vietnam.[91] It was a clear demonstration of the focus of the Air Force: Global Reach—Global Power. The cornerstone of this ability to project power quickly is the airlift provided by the Military Airlift Command (MAC). In the first 30 days of buildup during Desert Shield, MAC strategic airlift flew over 2,000 missions delivering over 63,000 tons of cargo and 81,000 passengers to the

theater.[92] "By the cease fire, airlift had moved over 482,000 passengers and 513,000 tons of cargo."[93]

As impressive as this airlift is, the task of tracking all the passenger and cargo movements was equally herculean. MAC urgently needed an automated tracking system. The system under development to do this is the MAC command and control information processing system (MAC C^2 IPS). The acquisition strategy calls for an evolutionary approach involving three increments. It provides MAC's lower echelons, command of airlift forces, airlift control centers, airlift control elements, and the airlift unit or wing with automated airlift management and message handling.[94]

On 5 September 1990, the commander in chief, Military Airlift Command (CINCMAC) notified the Air Force program executive officer that "I need this capability now, and I propose to take the necessary actions to allow Electronic Systems Division (ESD) to begin purchasing equipment as soon as the system is ready to be fielded."[95] In response to this message, the Air Force program executive officer for information management directed Electronics Systems Division on 11 September 1990 to rapidly develop, and immediately deploy, a limited information processing capability.[96]

The MAC command and control information processing system (HAVE IPS) was designated to meet MAC's Desert Shield requirements. HAVE IPS was a rapid development of a subset of the MAC C^2 IPS Increment 1 system. It provides MAC's lower echelons with a capability to track aircraft and cargo arrivals and departures. It monitors aircraft by tail number and includes the number of passengers the aircraft carries, how many pallet positions are full, and a description of the equipment carried (by the unit line number [ULN]). The HAVE IPS system interfaces with Headquarters MAC tracking systems, and, when fully implemented, will provide worldwide information on all MAC aircraft and cargo in transit.[97]

The HAVE IPS hardware was commercial-grade, existing equipment. This was considered adequate because the MAC concept of operations was to operate in a normal, office-like environment with standard power and air conditioning. Using commercial equipment would also minimize cost and schedule for hardware design. The development effort thus centered on software development, both for system operation and interfacing with the existing Headquarters MAC tracking system.[98]

Initial operational capability (IOC) for the Increment 1 for MAC C^2 IPS was scheduled for the first quarter of 1991. However, the contractor was behind schedule and the program office was considering sending the contractor a delinquency notice. The contractor's problems were a result of poor software development practices and discipline. To meet the urgent airlift management requirements, the program office began a high-risk effort to accelerate delivery of a portion of the Increment 1 software as HAVE IPS. The fixed-price development and production contracts were modified to do so.[99] The primary method the contractor used to compress the schedule was the deletion of computer software configuration item (CSCI) testing.[100] This approach proved to be fraught with problems.

The system was delivered to "10 locations in CONUS, Europe, and Saudi Arabia. Four systems were deployed in fixed bases and 6 deployable nodes were set up under field conditions."[101] The six nodes experienced installation and hardware problems because air conditioning and standard power were not available. An additional five locations in-theater did not receive HAVE IPS due to the limited availability of communications media in-theater.[102]

There were three attempts to deliver the HAVE IPS software. The hardware was shipped to Saudi Arabia in December 1990, and the initial attempt to install the software was made in January 1991. It did not perform satisfactorily. The contractor returned to troubleshooting and recoding, and installed the software again in March 1991. This time, performance was considered marginally effective; its poor performance was partly due to inadequate configuration management of the existing Headquarters MAC tracking system. HAVE IPS was once again returned to recoding and testing, and, after having been brought up to specifications, was finally delivered in July and August 1991, to support redeployment efforts.[103]

Lessons Learned

Software Acquisition

Software development requires a disciplined development process such as that defined by the Software Engineering Institute, Carnegie-Mellon University. The program office had accomplished several software audits and had identified the contractor as having an immature software development process. The immature software development process resulted in numerous problems—problems not expected from a developer using a quality process.[104]

Despite compressed schedules resulting from an urgent need, software development must follow the principles described in Department of Defense Standard 2167A (DODS 2167A), Defense System Software Development. In the HAVE IPS program, the testing and documentation requirements of DODS 2167A were not consistently applied. For HAVE IPS, computer system configuration item (CSCI) testing was eliminated in order to compress the software development schedule. This compounded the contractor's development problems. As a result, problems were not discovered until the nodes were installed in Saudi Arabia. For example, major interface problems between HAVE IPS and its parent system resulted in nonreceipt of required data, making the system unusable. In addition, insufficient documentation resulted in a lack of traceability for troubleshooting.[105]

The MAC C^2 IPS program office was directed by the Air Force Program Executive Office to field HAVE IPS. The MAC C^2 IPS office identified the fielding as "very high risk" due to past contractor performance. The program office attempted to field the system without thorough integration and testing, resulting in the delivery of a flawed system. Only through extensive testing and recoding was an operational system finally delivered.[106]

Contracting

The fixed-price contract hindered the contractor's effort.[107] The contractor wanted to implement the lowest cost, fastest solution to problems. These tended to be quick, temporary patches rather than an understanding and correction of the real cause. The program office avoided a potential adversarial relationship with the contractor by assisting his development effort.[108] A cost-reimbursement contract would probably have enabled the program office to avoid these difficulties. Time-sensitive efforts to support future war or other contingencies should use cost reimbursement contracts whenever possible.

Tactical Digital Facsimile

Just as it is difficult to imagine a modern peacetime military planning office without a facsimile machine, so it is with deployed units. The system that provided this capability for Operation Desert Storm was the tactical digital facsimile (TDF) portion of the intratheater imagery transmission system (IITS). This rugged fax unit gave Air Force and Marine units in Operation Desert Storm high-quality imagery for immediate intelligence analysis, mission planning, aircrew orientation, and battle damage assessment.[109]

The IITS is made up of two units: the interface processor for imagery exchange (IPIX) and the TDF.[110] The TDF is ruggedized to full military standards and is capable of secure transmission. The TDF interfaces with the military's digital troposcatter radio terminals, which gives it worldwide connectivity.[111] Because it sends and receives image data in 16 shades of grey with a resolution of 200 lines per inch, it provides better resolution than commercial machines. This is useful for reconnaissance photography and maps. It operates on any power source: batteries, generators, or commercial electricity.[112] The TDF primarily transmitted imagery intelligence directly to fighting units. It was a timely and secure way to update target folders with information and imagery on terrain, routes, headings, and threats—the kinds of things pilots have to know to survive.[113] In addition, the TDF can operate independently as a secure fax machine. With the IPIX, it can forward data to more than one user at a time or store it for transmission at a later time.[114]

At the start of Desert Shield, no IITS units had been delivered to field units. That changed in short order, however, as TAC began accepting units within three days. During the early phases of that operation, the TDF was the only secure form of communication available to some units.[115] By the end of the war, 105 units had been deployed and used in the Persian Gulf theater.[116]

Because the TDF had been fielded so quickly, there had been no operator or maintenance training prior to the deployment. The program office provided some training to deployed units over the telephone. They also put together a training team and provided some on-site training at Headquarters TAC, Langley AFB, Virginia.

Lessons Learned

Program offices should plan for the possible use of their systems during a contingency before development and fielding are complete. The program director for intelligence and C^3CM systems addressed some of the logistics and support concerns:

> In writing systems requirements and planning for system development, make provisions for the possibility of the prototype being called upon to support a contingency operation. For example, provide for portability, militarization, ruggedization, war readiness support kits (WRSK), and blue-suit maintenance early-on.[117]

This planning for early use should also include provisions for training of the system operators. Capt Mike Ott, the program manager for TDF, described their experience during Desert Storm.

> Because the TDFs were deployed so quickly and months ahead of schedule, some troops didn't know what to do with them. . . . Luckily our office was able to give instructions over the phone, and word of its performance spread quickly.[118]

The recommendation to plan for premature use of a system in combat includes the need to plan for contractor involvement. As with several other developmental systems deployed to the Gulf, IITS contractors helped support the systems' use. In addition to contractual provisions addressing deployment of civilian contractors to hazardous situations, the program office needs to plan for the costs that will accompany such work. "Associated costs include normal dislocation bonus, per diem, hazardous bonus supplements, and compensation to the employer for life insurance costs incurred by the company."[119]

Teamwork was once again cited as making a significant contribution to the accomplishments of the IITS program during Desert Storm. "I personally believe the greatest lesson from Desert Storm was the power of teamwork," said Captain Sorrells, program manager for IPIX. "We did in a couple of months what it takes many programs years to accomplish.[120]

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Chapter 5

New Systems Developed for Desert Storm

This is the last chapter about individual accelerated acquisition programs. It focuses on those new capabilities that were developed and delivered to support the Desert Storm effort. The three programs highlighted all capitalized on the use of existing and commercial equipment to reduce design and development time. We begin with a look at the system that received much renown during the final days of the war, the GBU-28 "smart bomb".

GBU-28

The GBU-28 was one of the shining stars of accelerated acquisition programs during Desert Storm. It is a true testament to the teamwork and spirit of the people who developed it.

Designed to penetrate hardened targets, GBU-28 not only performed its mission flawlessly, it was developed, tested, fielded, and employed in only six weeks. The GBU-28 is a laser-guided, conventional, hard target penetrator[1] weighing about 4,700 lbs.[2] Its fast-track development did not allow time for the design of new hardware. Consequently, it is an aggregate of components used in other munitions. It uses the guidance kit of the GBU-27, the tail assembly of the GBU-10, the fuze of the BLU-109, and the GBU-24 nose adapter. The body is made from scrap Army gun barrels.[3]

The story of the GBU-28 begins in September 1990 just one month after the start of Desert Shield. At that time, intelligence reports showed that we did not have a weapon that could penetrate Iraqi hardened bunkers and aircraft shelters.[4]

Munitions developers at Eglin AFB, Florida, started looking at various designs. At that time, design size was restricted to the size of the F-117A bay. None of the designs considered in the fall of 1990 was able to provide a significant increase over the existing BLU-109, or else they were considered to take too long to field. Shortly after the air war began, the allies achieved air superiority. This opened the door for expanding available delivery aircraft to non-stealth fighters and bombers like the F-15E and the F-111F. Without the size constraint of the F-117A bay, engineers were able to design a much larger bomb with tremendous penetration capability. By the end of January 1991, the preliminary bomb design was created.[5]

The real impetus came in January 1991 when "the assistant secretary of the Air Force for acquisition issued a call to industry for ideas about how to defeat hard targets."[6] The Air Force received about eight concepts in response. On 8 February, Headquarters TAC forwarded two of the most viable concepts to Eglin AFB for review and recommendations.[7]

Since hard target penetration is a function of weight, speed, and cross-section, the developers knew they needed a bomb larger than anything in the inventory.[8] The search began for a material large enough and strong enough to make the bomb body. One of the contractors (a retired soldier) suggested using scrap Army gun barrels. He knew that at Watervliet Arsenal, New York, there was an available supply of barrels made from the same hardened steel as existing BLU-109 penetrators. Enthusiastic cooperation by the Army made them available. The Army machined the gun barrels into bomb bodies at the Watervliet Arsenal.[9]

Meanwhile, on Saturday morning, 9 February, several other organizations at Eglin began their evaluations of the contractor proposals. The program office began working directly with the Headquarters TAC battle staff.[10] The Tactical Air Warfare Center and the 4486 Fighter Weapons Squadron began formulating operational concepts and evaluating proposals. On 12 February 1991, the Wright Laboratory High-Explosive Research and Development facility was told that "something big" was coming. The explosives lab immediately started making tritonal explosive pellets.[11]

By 14 February 1991, the development planning office was able to brief Lt Gen T. A. Baker, vice commander, Headquarters Tactical Air Command (Headquarters TAC/CV) on alternative designs. General Baker picked the GBU-28. By 16 and 17 February 1991, the first two penetrator shells arrived at Eglin from Watervliet Arsenal,[12] flown in by the 109th Tactical Airlift Group, a New York Air National Guard C-130 unit.[13]

Finally on 20 February 1991, the vice chief of staff of the Air Force, Gen John M. Loh, signed a message giving the program office program management direction to proceed and designating the GBU-28 program as a Rapid Response Program.[14] On 22 February 1991, the F-111F was chosen as the primary carrier. Flight test rehearsal and technical order verification were conducted the very next day. The following day, 24 February 1991, the first and only operational flight test was conducted at Tonopah Test Range. The penetration capabilities shown in the test exceeded requirements. The last test event, the sled test, was done on 26 February 1991 at Holloman AFB, New Mexico. This same day, two GBU-28s were shipped to Saudi Arabia. When placed in their shipping containers, they were still warm from the pouring of the explosives.[15]

The real test came on 27 February 1991, the last day of the fighting in the desert, in the first operational use of the GBU-28. The bomb hit its target precisely, penetrated successfully, and destroyed an Iraqi command and communications bunker.[16] Had the fighting continued, the GBU-28 would surely have achieved much more fame.

All of this may sound like a true rapid acquisition success story. It contains some of the classic features of an efficient and effective team: visibility and support from the very highest levels of the organization, and motivated and skilled team members doing what needs to be done. The users got what they wanted, got it very quickly indeed, and it worked. But even this program had some problems.

The primary problem of the GBU-28 development program seemed to be funding. Funding is needed in order to issue a legal contract, and adequate funding was not available at the start of the development program in February. Lt Col Bill Borchardt describes the problem from the contracting officer's perspective.

> On 14 Feb 91, a joint message from HQ USAF/XO/LE, SAF/AQ, and TAC/CV (141803Z Feb 91) directed us to design, develop, fabricate, and deliver this critical weapon. The same message directed [program management direction] PMD and financial support. The contractors proceeded at their own risk and were nervously calling WL/MNK daily for status on contractual direction and funding. The critical subcontractor [was] also working at his own risk. Both the prime contractor and the critical subcontractor feared that the war would end and they would not be reimbursed for their work. Due to a non-receipt of funding and desperate to keep the project alive, Wright Laboratory Armament Directorate gathered unobligated funds in order to provide 20% of the [not-to-exceed] NTE amount and issue the contractual document on 22 Feb 91.[17]

An Air Force official Major Wright described what happened: "We issued two contract actions on separate days, one for development and another for production."[18] The funding was finally received from SAF on 26 February 1991,[19] the same day the completed bombs left for Saudi Arabia and just one day before the fighting ended.

Lessons Learned

Teamwork! The team that Major Wright led is a sterling example of cooperation, cohesion, and commitment. They worked together flawlessly. Coordination of their efforts was superb. They were able to schedule work aggressively, using a highly concurrent schedule. They performed some tasks simultaneously, and sometimes even anticipated each others' requirements. For example, the test organization started planning the test program as soon the GBU-28 was chosen by TAC as the preferred alternative. The laboratory started gathering materials upon advance notice from the program office.[20]

Another important factor in this smooth coordination of effort was the collocation of research, development, test, and evaluation functions at Eglin.[21] Eglin AFB is unique among Air Force Air Materiel Command bases in having test ranges and operational test units right there.

The use of nondevelopmental items is an efficient way to get critical, effective systems to the field fast. For the GBU-28, the team used existing components to minimize development time, risk, cost, and support requirements.

The decision that directs a development program to proceed must also provide funding direction, even if that direction is to redistribute funds internal to the development organization. The GBU-28 was, in essence, a new start and had no source of funding. The laboratories were forced to redirect funds from other programs, which may now have to reschedule or scale back their other work. The fact that the contractor proceeded at his own risk while a source of funding was located is a testament to his patriotic commitment. He should not have been put in that position. The rapid response program should be institutionalized and streamlined, and clearly address funding.

Defense Meteorological Satellite Program and Rapid Deployment Imagery Terminal

The Defense Meteorological Satellite Program (DMSP) is basking in the warm sunshine of a successful acquisition in support of Desert Storm. Its High Gear project for the development and delivery of a highly mobile terminal swept through the acquisition processes like a strong, determined breeze.

DMSP provides visual and infrared satellite data for weather information for military users. At least two DMSP satellites are required in sun-synchronous orbits to provide 24-hour weather coverage. One satellite provides the early morning and early evening information, while the other covers midday and midevening. Four fixed-command readout stations provide for mission data recovery. The most recent configuration of sensors on the Block 5D-2 satellites assist weather forecasters in determining storm intensity. These sensors can also measure wind speeds over the ocean and estimate rain over land. In addition, a series of mobile ground stations at several fixed and deployed locations and on ships provide real-time weather information to military users worldwide.[22]

These existing mobile ground stations have some mobility constraints. They require a C-130 to transport them, so getting them to remote locations is not an easy task. In addition, the normal ground crew consists of 25 people, again not a trivial group to move and support.[23] For the Air Weather Service (AWS), the problems posed by these constraints came to the fore in the early days of Desert Shield. AWS was tasked to support massive numbers of combat forces in a distant and remote location, the Saudi Arabian peninsula. The crisis highlighted the need for a simple, lightweight, and rapidly deployable, direct-readout weather information terminal that could be used immediately.[24] Thus the concept of the rapid deployment imagery terminal (RDIT) was born. The RDIT that was ultimately developed and fielded fits in the back of a high mobility multipurpose wheeled vehicle (HMMWV) for easy movement to remote and rugged locations and requires only two people to operate it.[25] That is quite an improvement over the original mobile ground terminals.

The story of RDIT really began on 12 September 1990. That was when Air Weather Service sent a message to the Military Airlift Command commander,

Gen Hansford Johnson, identifying the immediate requirement for a lightweight, rapidly deployable DMSP imagery-receiving capability.[26] To reiterate the urgency, General Johnson forwarded the request to Gen Ronald Yates, the commander of Air Force Systems Command. In coordination with the program executive officer for space, Brig Gen Gary Schnelzer, General Yates designated the RDIT project as a High Gear project on 15 October 1990, barely a month after the original identification of the need.[27] Being a High Gear project would give RDIT emphasis and visibility, and also give it some priority as it navigated the sometimes stormy waters of acquisition.

The DMSP system program office (SPO) immediately formed a tiger team to accomplish the acquisition. The team was headed by Capt Kenneth G. Mims, of the DMSP system program office's operations and ground systems division. Technical experts, contracting people, and representatives from AWS and from Air Force Logistics Command were integrated on the team. They simultaneously developed technical, contracting, test and operations, and maintenance strategies.[28] Lt John Wade, a member of the team, describes their activities.

> To effectively compress these myriad activities, a three-person High Gear subteam emerged and assumed overall day-to-day management and oversight responsibilities . . . The subteam . . . brainstormed ideas, divided the work and delegated appropriate tasks to other team members. To do this, they analyzed everything first, eliminating or postponing tasks deemed unnecessary or unimportant. They also made sure that, where possible, all important tasks were worked in parallel and were given highest priority by the responsible parties.[29]

The acquisition strategy chosen had two primary components: a technical strategy and a contracting strategy. The technical approach involved developing evaluation criteria and analyzing trade-offs based on user requirements, cost, and schedule. Using these criteria, the team selected four existing and prototype commercial systems from a larger pool of available systems. Several team members witnessed demonstrations of these four. Based on their observations, the team identified two of the four systems as meeting most of the user requirements and as most likely to be delivered on schedule and within budget.[30] The technical strategy also included a "fly-off" competition: both units would be operationally tested. The winner would be awarded a further production contract.[31]

Because of the urgent need for the RDIT by AWS, the contracting strategy chosen was to issue a sole-source contract. To speed up the contracting process, letter contracts were issued to Harris Corporation and SeaSpace Company. They specified 31 January 1991 as the delivery date for two units per contractor. Both contracts also included options for maintenance support and for production of five more terminals.[32]

While the acquisition strategy was being implemented, some of the members of the tiger team focused on identifying an appropriate training and testing site. They chose White Sands Missile Range, New Mexico. It offered a desert-like environment, and direct support by the US Army Atmospheric Sciences Laboratory (ASL). The tiger team and ASL communicated daily,

working out every detail of the training and test plans and their schedules. The results of this teamwork came when the operational testing sailed along smoothly.[33]

The Harris unit was delivered to the test location in January 1991 to begin operator training and operational testing. By the end of the first full week of February, less than three months after the contract was awarded, the training had ended and testing had begun. Testing was done around-the-clock and was successfully completed four days later, on 7 February 1991, a full two weeks ahead of schedule. The very next day, 8 February 1991, the Harris unit was shipped to the Gulf.[34] Based on the results of training, operational testing, and initial user feedback, on 15 February, the SPO exercised the option on the Harris contract for production and maintenance of five additional units.[35]

The Harris unit arrived in the Gulf on 18 February and was operational in time to support the offensive ground operations that began on 23 February.[36]

By early March 1991, the SeaSpace unit had completed testing and arrived in the theater. It supported continuing ground operations. Together, these two terminals provide an interim capability until the more rugged and mobile system, called the Meteorological Satellite Small Tactical Terminal, can be developed.[37]

These successful operations herald an important benchmark: the first High Gear project to deliver operational capability to a user. Brig Gen John Kelly, the Air Force director of weather, summarized the program: "Our RDIT is a true success story. From start to finish, it took just four months from an idea to deployed hardware in Saudi Arabia. . . . RDIT met our need and performed as advertised. We're High Gear fans."[38]

Lessons Learned

Teamwork

It is essential to ensure early and continued communication with all organizations that are involved with some aspect of the acquisition and deployment of the system. The RDIT team encountered some problems in this area. Although the project team worked hard to identify and communicate with all major supporting agencies throughout the RDIT acquisition, some of the smaller organizations were left out of the coordination process. The team then faced delays and technical problems that could have been avoided.[39]

Early defense plant representative office (DPRO) involvement ensured a solid technical performance throughout the acquisition.[40]

Acquisition Strategy/Risk Management

The use of contractor off-the-shelf and nondevelopmental items (COTS/NDI) as a starting point minimized both development time and risk. It also pro-

vided a solid base for effective contractor logistics support of training and maintenance at minimum price.

The fly-off acquisition strategy enabled the program office to understand thoroughly the technology available at the start of the procurement, thereby minimizing technical and schedule risk.[41]

Concurrency can be an effective tool for accelerating acquisitions. Essential ingredients to its success are cooperation and teamwork by all participants and an acquisition strategy that addresses the risks of a concurrent program.

Contracting

If the contracting strategy is streamlined by using undefinitized letter contracts for urgent and compelling reasons, then the postaward process should be streamlined as well. The RDIT project team got bogged down trying to definitize the letter contracts; they still had to go through the usual lengthy proposal and evaluation process.[42]

Program Management

Ensuring program management directive (PMD) coverage is important.[43] The PMD provided direction for the program office to procure and deliver a small tactical terminal, which was occurring under the Meteorological Satellite Small Tactical Terminal (METSAT STT) project. Both the user (AWS) and the program office viewed RDIT as an interim small tactical terminal capability, and thus considered it covered by the PMD. During a program review of the METSAT STT, however, Mr Jack Welch, the undersecretary of defense for acquisition, objected. Immediately following that meeting, the PMD was revised to address the RDIT. RDIT was subsequently designated a High Gear project.[44]

Multiman Intermittent Cooling System

Imagine the searing heat of a hot summer day in the deserts of the Persian Gulf region. Imagine trying to work on an aircraft during that heat. Now imagine wearing a chemical protection suit while working on an aircraft in the desert heat. That was the problem Dr Robert J. Reyes, who heads the air base operability division at the Human Systems Division at Brooks AFB, Texas, had to solve. What he developed is the multiman intermittent cooling system, or MICS.[45]

The MICS is a cooling unit for people wearing chemical gear. It consists of a series of hoses and adapters that connect a C-10 flightline air conditioning unit to vests worn underneath the chemical suit. One MICS can cool up to 10 people. Two MICS can run from one C-20 cooling unit, cooling up to 20 people at a time.[46]

Even before the start of Desert Shield, the USAF School of Aerospace Medicine (USAFSAM) was looking at cooling vests. Dr Reyes explains:

The closed loop water vest, a system used by NASA, was very popular at that time because water looked like a more attractive approach—the cooling capacity of water is greater. But the Army had developped an air vest, which is now being used in the M-1 tank for continuous cooling of four men to a unit.[47]

Both vests were tested, yielding about equal results. The air vest had several advantages, however. People liked the air vest better because it was more like natural cooling. It also provided cooling to the face mask of the chemical ensemble, something the water vest did not. In addition, the air was fielded, "one size fit all, and the air vest was 10 times more economical."[48]

Next came the search for an air conditioning unit. Dr Reyes' team found that the C-10 air conditioning unit is standard equipment on the flightline. The next task was to develop an adapter to hook the MICS up to the flightline air conditioners. The Human Systems Program Office, in coordination with Dr Reyes' office, took on the task of designing, fabricating, and testing the adapter.[49] By this time, San Antonio Air Logistics Center agreed to manage the item. They required Level III engineering drawings so that the system could be easily manufactured. Just about the time the design and the drawings were complete, Desert Shield began. The production contract for the MICS was awarded to Fairchild Aircraft Corporation. To meet the urgent need, they worked round-the-clock operations. Several hundred vests were delivered and used in the field by the end of Operation Desert Storm.

Lessons Learned

The MICS made good use of nondevelopmental items to reduce their development cost and time. Both the air conditioning unit and the air vest were already developed and fielded. Only the adapter needed to be developed and manufactured in order to meet Air Force operational scenarios.

Once again, teamwork paid dividends. The words of Capt Thomas Sterle of the Human Systems Program Office state it nicely

The other payoffs are that we showed that we are responsive to our users' needs and we respond quickly. And this showed our close coordination with the other services. . . . It was inspiring to see the cooperation and teamwork achieved among HSD, Kelly and Fairchild people in fielding MICS. . . . People from vastly different organizations worked well despite the pressure of the accelerated schedule.[50]

Notes

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32. Wade, "High Gear," 17.
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45. "Cool Air for Hot Suits," *Leading Edge*, June 1991, 45.
46. James C. Hyde, "Services Accelerate Programs to Benefit Troops in Middle East," *Armed Forces Journal International*, October 1990, 20.
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Chapter 6

Lessons Learned
An Evaluation of Acquisition Processes Used to Support Desert Storm

Although the experiences of individual program offices as well as their specific contributions to Desert Storm varied widely, several trends and lessons emerge. In many areas, established acquisition processes were confirmed. In some areas, however, shortcomings and opportunities for improvement were identified. The following discussion highlights the significant lessons learned from across the command.

Planning

Formal planning to support contingency operations should be accomplished on several levels: at the command headquarters and at the program office, as well as within the Program Executive Officer organization.

- Air Force Materiel Command should plan for the use of developmental systems during contingencies.
- Programs that are eligible for deployment should plan for contractor support and support of contractors.

At the command level, Headquarters AFMC should create an annex for the use of developmental and new systems during contingency operations in their war and contingency support plan. It should identify those systems in the production and deployment phase that could be used during a war. This list should be updated annually. For all systems identified in the Headquarters AFMC plan, the program office should establish more detailed plans (see below). Headquarters AFMC should further work with the using commands to establish plans for the beddown and support of deployed product support teams. (See Product Support, below.)

In the program office, contingency support plans should be established no later than the start of low-rate initial production. This should be done by both government and contractor and can be done as part of the production plans. The plan should identify risks of going to war with immature weapons systems. The plan should identify shortfalls: subsystems, qualification testing,

integration, spares, quantities, repair capabilities, and WRSK. It should address spares, training, contractor, and depot support. The program office plan should also contain a war and mobilization section that specifically names team members who would deploy to provide operations and logistics support to the system in-theater. This section should address the training and use of individual mobilization augmentees (IMA) from the Air Force Reserve. The plan should lay out team support requirements, to include communications with the program office, operations procedures, protective gear and training, and in-country and family support. These requirements must be coordinated with the operating command.

Lastly, the provisions of the contingency plan must be reflected in the contract. This can take the form of options or clauses, such as the warranty and logistics support clauses used by the LANTIRN program. There must be provisions for funding procedures, production hardware loan/payback procedures for wartime support, and maintenance and support of the system. Additional compensation and insurance for contractor members of the product support team may need to be addressed.

Product Support

When the acquisition of a system is accelerated to participate in a contingency such as Desert Storm, there may be insufficient time to plan and acquire the support for that system. Air Force technicians may not have much experience with the new system or may not be fully trained. Technical orders may still be in the preliminary stage. Spare parts may not yet be fully stocked. If any of these conditions exist, extraordinary measures will need to be taken for the new system to meet its wartime commitment. These problems were encountered during Desert Storm and resulted in the following lessons.

- Product support teams made significant contributions to the operations and maintenance of systems deployed before reaching full operational capability.
- For systems that had not reached full operational capability, contractor direct maintenance and operations assistance in-theater often made the difference between a mission-capable system and a down system.
- Low spares levels of new or developmental systems need special attention and handling in order to meet mission requirements.

The F-15E, LANTIRN, and J-STARS programs deployed product support teams (PST) to the theater of operations. The PSTs worked closely with system maintainers and helped expedite the movement and repair of the limited spare parts. Prime contractors' field service representatives from all three programs were particularly valuable members of the PSTs. They were able to perform some repairs that were beyond the capability of base-level mainte-

nance because of their design and test experience with those systems. In addition, they performed many critical maintenance and operations support tasks, including depot maintenance tasks that were beyond the capability of the Air Force's base-level maintainers. The LANTIRN contractors also clarified technical order procedural items in both aircrew and maintenance manuals and designed procedural enhancements and workarounds to alleviate an intermittent problem in the immature built-in test. The contractors are credited with preventing the loss of numerous combat sorties.

Contractor support of the J-STARS in-theater was even more extensive and critical. Because the system was still four or five years away from its initial operational capability when it deployed, the Air Force's ability to maintain and operate the system was extremely limited. The contractor maintained the aircraft, and a number of the key positions on the mission crew were manned by contractors. They also provided Joint STARS with an on-site engineering capability which perfected the operational software.

Just as new, immature systems will have limited operations and maintenance experience, so are they likely to have insufficient spare parts. The initial purchase of spares may not yet be complete. Also, the higher failure rate of an immature system may draw more heavily on the available stock. When such a system is deployed to war, the demand rate will increase and exacerbate the situation. The F-15E and LANTIRN PSTs were able to handle these problems by establishing direct communications links between the deployed location and the program office. They were able to expedite spares deliveries from either the development contractor or the air logistics center. In addition, in-theater contractors were able to perform some repairs that obviated the need to draw upon the strained transportation and supply systems.

The spares situation for J-STARS was even more critical. Because the system was still in the engineering and manufacturing development phase of development, it did not yet have an established depot or supply base. While the users were able to capitalize on commercial support for the Boeing 707 in Europe and AWACS support in-theater, vendor support for unique items was extremely limited. In addition, unique items were not yet listed in the government supply system. This caused problems in tracking and expediting their delivery because the transportation system had no way to track them. Special manual handling was provided by both contractor and military personnel.

Acquisition Planning/Risk Management

The challenge to acquisition managers during Desert Shield/Desert Storm was to provide urgently needed combat capability quickly while still keeping their costs under control. The methods used were tried-and-true techniques that once again proved their value. We affirmed the following acquisition acceleration processes.

• Use of fly-off, nondevelopmental items, and contractor-off-the-shelf items (NDI/COTS) reduces technical risk, cost, and schedule.

• Negotiating a not-to-exceed (NTE) price minimizes the cost risk of a fast-track modification to support a contingency.

• Concurrency remains an effective tool for accelerating acquisitions, but it must be managed carefully to ensure adequate coordination between activities.

Several of the programs that accelerated their acquisitions to support Desert Storm employed techniques commonly used to minimize risk in normal acquisitions. NDI/COTS equipment is equipment that has already been designed and produced by a manufacturer. Some of the programs that used NDI/COTS include the multiman intermittent cooling system, the Defense Meteorological Satellite Program (DMSP), and the GBU-28. Since NDI/COTS does not require new developmental engineering work by the contractor, the technical difficulties that can sometimes accompany that type of work are thus avoided. In other words, the technical risk is reduced.

It is important to note that the principle of low technical risk associated with NDI/COTS items applies only when no or little developmental work is required. If significant developmental work is required, such as the software integration of several pieces of NDI/COTS hardware in the case of the HAVE IPS program, technical risk may be high.

Returning to the use of NDI/COTS equipment, because these items have already been produced, the contractor has actual data about the manufacturing costs and schedule. The task of negotiating a fair and equitable price for a quantity of these items is thus a relatively simple one. The contractor also has actual production schedule data. The cost and schedule risk to both the government and the contractor associated with such a negotiation is low.

An additional benefit of using NDI/COTS equipment is that it provides a solid base for effective logistics support, training, and maintenance at minimum price. It is likely that the contractor has already provided these or similar services to previous customers and, again, has actual cost data upon which to base negotiations with the government.

Another way to minimize technical risk is to use a fly-off acquisition strategy. The DMSP program successfully used this technique. After narrowing the field of potential bidders down to two, the government required that each contractor build a unit and deploy it to Saudi Arabia for demonstration, test, and actual field use. Thus the technology was proven. Nothing was inadvertently overlooked, as can sometimes happen in a laboratory or test environment. Based on the results of these real field activities, the final selection was made.

While all these efforts may serve well to define and limit the technical risks of a fast-track program, limiting the cost risk must also be addressed. One method that has been frequently used is the fixed-price contract. The government knows what the cost will be; the risk is left to the contractor. He must manage his costs in such a way that he will have a profit when all the work is

done. But, as is discussed in the contracting section below, this approach can inhibit the contractor's efforts. This may not be tolerable in a contingency situation that requires the best technical solution.

A cost reimbursement contract may be the better approach, especially when a way to limit cost risk is used. This is exactly what the J-STARS program office did. It established a not-to-exceed price for the undefinitized contract effort that defined the deployment. In addition, it issued a contract change addressing the cost and schedule impact to the development contract. This was accomplished with a bilateral change order that included both an NTE price impact and an NTE schedule delay. Thus the J-STARS program office defined and limited its cost and schedule risk for both the support of Desert Storm and the continuation of the program once the contingency was over.

Another tried and true method of compressing an acquisition schedule is the use of concurrent schedules. Both the GBU-28 and DMSP programs relied heavily on this technique. Essential to the successful use of concurrency is teamwork by all participants and an acquisition strategy that addresses the risks of a concurrent program. Both teamwork and risk management have been discussed above. The same principles apply when conducting concurrent activities.

Contracting

In general, contractors responded enthusiastically to our urgent needs to field and support systems for the Desert Storm war effort. The type of contract chosen to support a contingency operation, however, can affect the quality of the contractors' efforts. In general, a fixed-price contract can restrain their efforts while a cost reimbursement contract can free them to concentrate on their best technical work. These considerations are important in a contingency because there may not be time for rework and retesting. The lessons can be stated as follows:

- Fixed price contracts can impede working relationships and contractor effectiveness.
- Cost reimbursement contracts worked well.
- The production contract should define the contractor's role and responsibilities in case the system is used in war before initial fielding is complete.
- A warranty clause and an interim contractor support clause for depot support can ensure the rapid return and repair of spare components. These clauses should be considered on production contracts that plan for the support of contingency.

The impact of contract type was experienced by the HAVE IPS and J-STARS programs. HAVE IPS used a fixed-price contract for both their basic and accelerated efforts. As a result, when the contractor ran into problems, he wanted to implement the lowest cost, fastest solution to problems. These

tended to be quick, temporary patches rather than a complete understanding and correction of the real cause. This could have brought about an adversarial relationship with the program office. Program office people avoided that situation by assisting the contractor in his development effort.

The J-STARS program, on the other hand, found that the cost reimbursement feature of the deployment contract change fostered a close working relationship between the contractor and government personnel. Their basic development contract was a fixed-price contract, and the contractor was in an overrun situation (i.e., the cost to the contractor was higher than the negotiated price of the contract). Contractors in this situation sometimes use less than optimal problem-solving techniques. The cost reimbursement structure for deployment allowed the contractor to put aside financial concerns and concentrate on providing needed capability to the war effort.

The CENTAF rapidly deployable integrated command and control system (RADIC) also had a positive experience with the cost reimbursement contract. CENTAF's effort was to upgrade two existing RADIC units and to build one more. Previous experience with the contractor on a fixed-price contract showed that solving technical problems can be difficult because of the cost to the contractor. The decision to avoid that situation and to use a cost reimbursement contract during the war worked out well.

All of the programs cited above modified their contracts or awarded new contracts to support contingency operations. It may be possible to structure the basic contract to provide this support. Modifications or additional contracts may be unnecessary. (Refer to the discussion of planning in chapter 6.) The production contract can define the contractor's role and responsibilities in case of war before initial fielding is complete. This flexibility can be provided in the form of priced options or clauses and should be part of the initial acquisition strategy. It should address both personnel and equipment concerns. Some contractors were reluctant to send field service representatives to the deployed location until they had an appropriate contractual vehicle in place that addressed their concerns about the hazards their people would experience. Although that is a perfectly reasonable position for them to take, it can delay effective support to combat operations.

Support and maintenance of the deployed system should also be addressed in the production contract. The F-15 SPO used many undefinitized contract actions (UCAs) to authorize such activities as borrowing production assets for use as spares and to effecting certain aircraft modifications. UCAs expose the government to uncontrolled contractor costs and can be a risky way of conducting business. The LANTIRN SPO used a different approach. A warranty clause and an interim contractor support clause for depot support were already in place on the LANTIRN contract and were exercised to support the war effort. They ensured the rapid return and repair of spare components. Clauses such as these should be considered on production contracts that plan for the support of contingencies.

Funding

During Desert Shield and Desert Storm, funding of accelerated acquisitions occurred in two ways: through internal reprogramming as in the High Gear programs and through supplemental funding as with the Rapid Response program and programs that received other direction. High Gear programs, such as DMSP, understood that the ground rules called for redistribution of funds internal to the program; no new funds would be made available. Any unfunded requirements created by this diversion of funds would be addressed during normal budget request cycles. Although there was no assurance of additional funding, at least the rules were clear. For other programs, such as J-STARS, LANTIRN, and F-15E, the rules were not clear. The following lessons emerged.

- Funding procedures, especially for Rapid Response Process programs, were generally confusing.
- Program direction that directs the acceleration of a program to support contingency requirements should address funding, even if the direction is to reprogram funds internal to the program office.

Funding procedures for contingency procurements need to be clarified and institutionalized in the appropriate regulations or policy statements. At the very least, the decision that directs a development program to proceed with deployment (either Rapid Response program or other direction) must also provide funding direction, even if that direction is to redistribute funds internal to the development organization. The experience of the GBU-28 illustrates the problem. Rapid Response programs like the GBU-28 were assured that funding would be made available. For GBU-28, however, it was not available in a timely fashion. Because of this, and because the GBU-28 was a new program with no prior funding to redistribute, the laboratories at Eglin AFB were forced to redirect funds from other programs in order to award the contract for production. Funding direction should accompany the direction to proceed with the development.

Programs like J-STARS, LANTIRN, and F-15E were neither High Gear nor Rapid Response programs. Their source of funding was not addressed with their direction to support the operations in the desert. The result was confusion and concern by SPO financial managers. They diverted research and development dollars to the war effort. The FY91 Supplemental Appropriations, which provided funds after the conclusion of hostilities, funded operations and maintenance only and did not reimburse R&D expenditures.

Production and Manufacturing

While American industries and technology made significant contributions to the Desert Storm effort, it is important to keep in mind that their capacity is not infinite. In at least one case, Department of Defense requests exceeded

a manufacturer's capacity. The lessons learned from Desert Storm can be summarized as follows:

- The AF needs to maintain discipline when accessing contractors' production capabilities.
- Cost reduction and efficiency measures that may be implemented in the interest of the bottom line or as part of a total quality program could impact a manufacturer's capability to support a surge in production.

The government needs to follow established procedures when accessing contractor's production capabilities. Two problem areas were experienced by programs accelerated to support operations Desert Shield and Desert Storm. First, even though the program office is designated the single procuring agent for programs in development, the GPS program encountered government violations of that principle. Some using organizations ordered and received GPS receivers through their own contracts. Not only was this more costly to the using organizations in terms of unit cost and reduced warranty, it also caused a problem for the program office because overall requirements exceeded production capability. The ability to prioritize deliveries had been circumvented.

The second problem area resulted from government abuse of the F-15E contractor's priority system. The F-15 chief of production confirmed that the Desert Shield/Storm project code was misused. Some Air Force organizations used Desert Storm as an opportunity to fix support problems not related to the war. They requested expedited spares and repairs for lower priority operating units. The result was premium effort being applied to noncritical activities. At a minimum, expedited requests cost more than routine requests. Over the long run, if the contractor diverts his resources to problems not related to the war effort, a negative impact on war-fighting capability can result.

The third manufacturing lesson is that cost reduction and efficiency measures implemented in the interest of the bottom line or as part of a total quality program should be examined in light of surge and other impact on war-fighting capability. An example from the F-15E Desert Storm experience illustrates the point. Although McDonnell Aircraft Company was responsive to government requests, cost reduction moves by McAir and by other industry leaders may have a negative impact on future contingency spares support. McAir is acting to reduce manufacturing costs by switching to a just-in-time inventory. McAir has expressed the concern that if that system, as well as other work-in-progress reductions, had been in place, they would not have had enough assets to support Desert Storm requirements. The Air Force needs to ensure that incentives it provides contractors to reduce their costs are balanced with wartime requirements.

Incremental Fielding

There is a school of thought within the acquisition community that advocates incremental and early fielding of weapon systems as a way to get war-

fighting capability into the hands of the users quickly and cost effectively. Although this was not the plan when Desert Shield started, it is, in effect, what happened for several programs.

The Joint STARS program, for example, was still in the engineering and manufacturing development phase when it deployed. Although this deployment caused about a six-month slip in the schedule, the suppliers got a better idea of what areas needed to be focused on during development, and the users got a chance to examine and refine their operational concepts years before they normally would. The information learned during the deployment was also used for the advanced buy decision in January 1992. In addition, the program office established the capability analysis program (CAP), which took all of the inputs from the Desert Storm participants and compiled them into various categories, considered whether they were already part of the FSD program, part of the 3d Aircraft Program (follow-on FSD), or should be part of the P^3I.

The DMSP rapid deployment imagery terminal (RDIT) program also fielded a capability in what can be considered an incremental and early fashion. Under their fly-off acquisition strategy, both the Harris and SeaSpace units were tested and then used in the desert. This type of fly-off activity is normally part of the demonstration and validation phase of acquisition. The winner then moves forward into engineering and manufacturing development. The DMSP small RDIT terminals, however, were fielded immediately. The results of this fielding and feedback from the user were then used to determine further development and production activities from which the Meteorological Satellite Small Tactical Terminal (METSAT STT) can be developed. The RDIT program provides an interim capability until the METSAT STT can be delivered. The user has been enthusiastic about this approach.

Two other programs, GBU-28 and LANTIRN, also benefited from their early fielding. The GBU-28 program personnel learned valuable lessons and demonstrated the concept that will be used in the development of a boosted penetrator bomb. In addition, the GBU-28 has since been tested on the F-15, and the Strategic Air Command has expressed an interest in acquiring such a capability. Developers of the LANTIRN targeting pod will expand its operational concept as a result of its use in Desert Storm.

One way to implement the concept of incremental fielding is to schedule the use of new systems during regular exercises while the program designers are conducting developmental tests and evaluation. Exercises, such as Desert Flag, Team Spirit, REFORGER, and Bright Star, could provide valuable operational lessons in a wide variety of environments. This early use of test or prototype assets could impose additional cost and schedule risk because such assets are usually in short supply. Damage to the assets could cause schedule delays to the remainder of the test program while these assets are repaired or replaced, with the attendant cost impact. The costs and benefits of this approach should be weighed during the initial structuring of a program and should be considered during the acquisition strategy formulation.

Software Acquisition

Software and computer systems are becoming an increasingly important part of modern weapon systems. Because of that, it is imperative to adhere to accepted software development procedures despite urgent schedule requirements.

The experience of several systems during Desert Storm illustrates the need to follow proven and accepted software development principles, such as those described in DODS 2167A. In the HAVE IPS program, the testing and documentation requirements were not consistently applied. Computer software configuration item (CSCI) testing was eliminated in order to compress the software development schedule. As a result, problems were not discovered until the nodes were installed in Saudi Arabia. For example, major interface problems between HAVE IPS and its parent system resulted in nonreceipt of required data, making the system unusable. In addition, insufficient documentation resulted in a lack of traceability for troubleshooting. Only through extensive testing and recoding was an operational system finally delivered. In contrast, the other programs that fielded significant software modifications or upgrades (J-STARS, HARM, RADIC) followed proven software development principles and were successful.

Teamwork, Communication, and Customer Focus

If there is one theme that came through loud and clear from our experiences in Desert Storm it is that a cooperative, cohesive, committed team focused on providing the customer with an excellent product can make a difference. While this conclusion may not be a new concept, it confirms the emphasis that the command Total Quality Management (TQM) initiative places on teamwork and customer focus.

Essential to teamwork is good communication—communication that includes all team members, regardless of the size of their contribution, their physical location, or their position on the organization chart; communication that begins with the inception of a program and continues throughout its progress; and communication that frequently updates members. Many of the program offices attribute much of the success they experienced in fielding systems quickly and supporting them effectively to solid teamwork and constant communication. Some of the problems they experienced can be traced to instances of communication lapses. The following examples illustrate this.

The GBU-28 team, which designed and delivered its system in 10 weeks, could not have done so without aggressive teamwork and excellent communications. Theirs was a highly concurrent schedule. They performed some tasks simultaneously, and different groups sometimes even anticipated each others' requirements. For example, the test organizations started to plan their activities while TAC was chosing the weapon concept. The laboratory started to mix and pour explosive pellets before the design was complete.

Likewise, the F-15E and LANTIRN teams demonstrated cooperative teamwork and strong communications to keep their larger and more diverse teams coordinated. Like the GBU-28 team, they had both government (development and test) and contractor members. Their government members also included people at their Air Logistics Center. The F-15E program also enjoyed extraordinary involvement from its Defense Plant Representative Office (DPRO), which performed manufacturing inspections simultaneously with the contractor.

In contrast, the value of good communication was also learned from a few instances of communications problems. On the DMSP program, for example, although the project team worked hard to identify and communicate with all major supporting agencies throughout the Rapid Development Imagery Terminal (RDIT) acquisition, some of the smaller organizations were left out of the coordination process. The team then faced delays and technical problems when action was required from one of the organizations that had been omitted. The F-15E program experienced a similar slowdown. In their haste to solve a problem quickly, they left Headquarters TAC out of the communications process. When funding was required from the headquarters, additional time was required to reconfirm the requirement.

The ultimate focus of this teamwork and communication is, of course, the customer, and providing him with the best possible war-fighting tools and technology. The programs discussed in this study consistently focused on their customer. Most of them deployed teams to the theater in order to provide effective support. The examples of the F-15E, LANTIRN, J-STARS, HARM, and IITS have been discussed in the previous sections. The GBU-28 program also had the benefit of having its customer reside on the same base, actively participating in the design and development effort.

In all, good communication is essential to building a solid team, which in turn can expedite an accelerated acquisition program, delivering needed combat capability into the hands of our war fighters quickly.

Overall Evaluation

In all, Air Force Systems Command responded quickly and effectively to support the technological needs of Desert Storm. However, improvements can be made in our planning for participation in future contingency efforts. The planning needs to encompass not only formal plans, but also the way in which our funding procedures and contracts are structured. The following chapter highlights the recommendations made throughout this section.

Chapter 7

Recommendations

The preceding evaluation of acquisition processes used to accelerate the delivery of weapon systems and capabilities to Desert Storm leads to the following recommendations. The first two recommendations apply to contingency support. The last two apply to routine acquisitions.

Planning

There are two types of planning to be considered: formal planning and acquisition strategy and contract planning. This planning needs to be a coordinated effort from the smallest program office up through the command headquarters and with the operating commands.

Formal Planning

Air Force Materiel Command should plan for the use of developmental systems during contingencies. Formal planning to support contingency operations should be accomplished at both the command headquarters and at the program office.

At the command level, Headquarters AFMC should create an annex for contingency operations in their war and contingency support plan. It should identify those systems in the engineering and manufacturing development phase or the production and deployment phase that could be used during a contingency and should be updated annually. For all systems identified in the Headquarters AFMC plan, the program office should establish more detailed plans (see below). Headquarters AFMC should further work with the using commands to establish plans for the beddown and support of deployed product suoport teams.

In the program office, contingency support plans should be documented no later than the start of low-rate initial production. This should be done by both government and contractor and can be done as part of production planning. The plans should identify risks of going to war with immature weapons systems. It should identify shortfalls in qualification testing, integration, spares, quantities, and repair capabilities. It should also address training, contractor, and depot support as well as manufacturing surge capabilities.

Programs that are eligible for deployment should plan for deployment of both government and contractor personnel in support of their system in-theater.

The program office plan should specifically name deployment team members. The plan should describe team support requirements, to include mobility training and preparation, communications with the program office, deployed team authority, and operations procedures.

Acquisition Strategy and Contract Planning

The production contract should define the contractor's role and responsibilities in case the system is used in war before initial fielding is complete. This should include emergency funding procedures, use of production hardware and loan/payback procedures for contingency support from the production line. In addition, a warranty clause and an interim contractor-support clause for depot support can ensure the rapid return and repair of spare components.

Funding

Funding procedures, especially for Rapid Response Process programs, were generally confusing. Funding procedures for contingency support programs should be formally established and well publicized.

Program direction that directs the acceleration of a program to support contingency requirements should address funding, even if the direction is to reprogram funds internal to the program office.

Incremental Fielding or Early Use of Developmental Systems

The incremental fielding or early use of developmental systems in exercises can benefit the user in terms of better defined operational requirements. It can also benefit the developer with early, realistic tests. Because of these benefits, acquisition programs should consider the incremental fielding or early use of their systems in major exercises whenever possible.

Teamwork, Communication, and Customer Focus

If there is one theme that came through loud and clear from our experiences in Desert Storm it is that a cooperative, cohesive, committed team focused on providing the customer with an excellent product can make a difference. This confirms the emphasis that the command's quality management initiatives place on teamwork and customer focus. This emphasis should be maintained. In addition, operational assignments and orientation visits for both military and civilian acquisition managers should be stressed and supported by both program office and command leaders.